PhD Thesis:

CHANGING ACCESSIBILITY AND MOBILITY PATTERNS IN RECONFIGURED RURAL METRO-ADJACENT REGIONS. THE CASE OF CASTILLA-LA MANCHA IN THE CONTEXT OF THE MADRID POLYCENTRIC URBAN REGION.

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A mis padres, Ramón y Teresa
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Summary

During the last decades, traditional monocentric metropolitan systems are evolving to polycentric ones, characterized by externalities shared among a collection of close-by and linked cities (either with or without a main city still exerting a principal role). As a result, and partially supported by transport networks improvements (especially road infrastructures), metropolitan centers are expanding their influence towards wider contexts leading to an interweaving of the metropolitan systems and their adjacent regions’ urban systems. Moreover, emerging urban systems no longer meet relational hierarchical or monocentric logics but also periphery-periphery or center-periphery ones.

While these metropolitan reorganizations have been extensively explored, until now, studies have focused on large and global cities and their close by surrounding peri-urban areas. Motivated by the need of in depth explorations on whether these changes are also transforming other types of rural areas further away from metropolitan centers, the main contribution of this thesis is the proposal of a combined morphological and functional methodological approach (which addresses accessibility and mobility analyses) to understand urban reconfigurations within rural metro-adjacent regions traditionally characterized by their leaderless and without internal functional cohesion character. A special attention is paid to assess to what extent the scale shift of metropolitan territories (overflowing their influence/effects towards wider areas) and the changes brought about by a state rescaling are conditioning transformations on these regions’ urban systems and functional coherence and favoring the consolidation of a more cohesive regional urban structure.

The empirical analyses of this thesis focus on Castilla-La Mancha, a Spanish rural region under the influence of the Madrid Metropolitan Region, and compare the current situation (2011/2012) with that previous to the Spanish state re-scaling (1981). These time scenarios allow considering two transport investments rationales: the traditional national one and the recent ‘national-regional’ one. Findings reveal that the reorganization processes initiated during the 1970s and the increasing metropolitan dynamics overflow beyond the traditional administrative limits have led to morphological and relational changes not only within the traditional metropolitan areas but also within their adjacent rural regions, shaping their rural settlement systems and conforming new regional organization patterns.
In these significant rural metro-adjacent regions’ transformations, the promotion of tangential transport infrastructures (connecting internally the region) in contrast to the traditional radial ones (connecting the region with the metropolitan center) have played a key role. On the one hand, by enlarging catchment areas and fostering potential interconnections not only with the metropolitan center but also among regional territories. On the other, by strengthening internal cohesion, which means more balanced development with fewer disparities and territorial imbalances.

These transport improvements have also motivated a relational change. This is evidenced by a growth in the number of flows, which allow a regional transformation from a predominantly rural behavior towards a more urban, or even metropolitan, one. The relational change is also evidenced by a reorganization of functional linkages (commuting) towards more complex spatial distributions characterized by: a) internal articulation reinforcement; b) metropolitan influence strengthening; and c) inter-regional interactions decrease (excluding those with the adjacent metro region).

All this has evidenced that recently reconfigured rural metro-adjacent regions (highly influenced by the extension of metropolitan dynamics) are overcoming their traditional acephalic/leaderless and without functional cohesion character and are becoming a polycentric urban system. Nonetheless, this polycentric configuration is still weak and fragmented/dispersed in contrast to that concentrated in the close proximity to the metropolitan center.
Durante las últimas décadas, los tradicionales modelos metropolitanos monocéntricos están evolucionado hacia otros de tipo policéntrico, caracterizados por la distribución de las externalidades en una serie de ciudades próximas y conectadas entre sí (con o sin una ciudad principal que ejerza un papel predominante en la organización del sistema urbano). Como resultado, y en cierta medida apoyado en las mejoras de las redes de transporte (principalmente la de carreteras), los centros metropolitanos están expandiendo su influencia sobre territorios más amplios dando lugar a la interconexión entre los sistemas urbanos metropolitanos y los de sus regiones rurales adyacentes. Asimismo, estos sistemas urbanos emergentes han pasado de estar caracterizados por relaciones funcionales jerárquicas y monocéntricas (dirigidas hacia el centro metropolitano) a otros más complejos con flujos más dispersos (periferia-periferia y centro-periferia).

Sin embargo, hasta ahora estas reorganizaciones metropolitanas han sido exploradas fundamentalmente en las principales ciudades globales y las áreas periurbanas que las rodean. Ante la necesidad por descubrir si estos cambios están transformando igualmente otro tipo de áreas rurales a mayores distancias del centro metropolitano, la principal contribución de esta tesis es la propuesta de una metodología que combina una aproximación morfológica y funcional (a través de análisis de accesibilidad y movilidad) para entender las reconfiguraciones urbanas en regiones rurales metropolitanas tradicionalmente caracterizadas como espacios desorganizados, desestructurados y carentes de cohesión funcional. Los análisis aquí realizados prestan especial atención a los efectos que el cambio de escala de los territorios metropolitanos (cuya influencia ha desbordado hacia territorios más amplios) y los procesos de re-escalamiento del Estado Nación están condicionando las transformaciones en los sistemas urbanos y la coherencia funcional de estas regiones, favoreciendo la consolidación de una estructura urbana más cohesionada a escala regional.

Los análisis empíricos realizados en esta tesis se centran en el caso de Castilla-La Mancha (España), una región rural bajo la influencia de la región metropolitana madrileña, y compara la situación actual (2011/2012) con la existente antes de que tuviera lugar el re-escalamiento del estado español (1981). Estos escenarios temporales permiten además analizar dos lógicas diferentes en el modelo de inversión de las infraestructuras de transporte: la tradicional lógica nacional y la reciente ‘nacional-regional’. Los
resultados revelan que los procesos de reorganización iniciados durante la década de los setenta del s. XX y el desbordamiento de la influencia metropolitana más allá de los límites administrativos, han dado lugar a cambios morfológicos y funcionales no solo en las tradicionales áreas metropolitanas sino también en las regiones rurales adyacentes, dando forma a su sistema de asentamientos rurales y conformando nuevos patrones de organización regional.

En estas significativas transformaciones que están teniendo lugar en regiones rurales metro-adyacentes, la creación de infraestructuras de transporte tangenciales (conectando internamente la región) frente a las tradiciones infraestructuras radiales (conectando la región con el centro metropolitano) ha jugado un papel crucial. Por un lado, mediante la extensión de las áreas de influencia de los principales núcleos urbanos, fomentando las interconexiones potenciales no solo con el centro metropolitano sino entre diversos puntos del territorio regional. Por otro, reforzando la cohesión interna, lo que se traduce en un desarrollo más equilibrado y la reducción de las desigualdades territoriales.

Dichas mejoras de transporte han motivado asimismo un cambio en las relaciones funcionales. Esto se evidencia en un incremento de la movilidad regional, lo que viene a indicar que frente a su tradicional carácter predominantemente rural, estas regiones están evolucionando hacia otro más urbano, o incluso metropolitano. Además de un aumento en el número de desplazamientos, ha tenido lugar una reorganización de las relaciones funcionales (commuting) hacia distribuciones espaciales más complejas, caracterizadas por: a) refuerzo de la articulación interna; b) extensión de la atracción/influencia metropolitana y c) disminución de las relaciones interregionales (excluyendo aquellas con la principal región metropolitana adyacente).

Todo esto pone de manifiesto que las recientemente reconfiguradas regiones rurales metro-adyacentes (altamente influenciadas por procesos metropolitanos, en continua expansión) están superando su tradicional carácter acefálico y falto de cohesión funcional y evolucionando hacia sistemas urbanos más policéntricos. No obstante, a diferencia de los espacios más próximos al centro metropolitano, esta configuración policéntrica es todavía débil y fragmentada/dispersa.
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PART I – INTRODUCTION
Chapter 1

Presenting the thesis and research topics

1. STATE OF THE ART. TRANSPORT SYSTEMS AS A CORNERSTONE IN THE EMERGENCE OF POLYCENTRIC URBAN CONFIGURATIONS

Following the 1960s seminal works of Gottmann (1961), who pointed to the emergence of a multinodal region or megalopolis, and Hall (1966), who identified a polycentric type of metropolis beside the traditional highly centralized principal city, many scholars have concerned about the emerging polycentric spatial configurations consisting of interlinked but physically separated medium-sized urban centers (Gordon et al., 1986; Garreau, 1991; Berry and Kim, 1993; Camagni and Salone, 1993; Gordon and Richardson, 1996; Anas et al., 1998; Dieleman and Faludi, 1998b; Knapp, 1998; Lambooy, 1998; Champion, 2001; Kloosterman and Musterd, 2001; Scott et al., 2001; Davoudi, 2003; Hall and Pain, 2006; Hoyler et al., 2008; Lambregts, 2009; Burger and Meijers, 2012; Ureña et al., 2013).

This concern has been particularly notorious during the past 15 years, when this spatial phenomenon has started being more clearly visible. Until then, research had been strongly focused on large cities (such as the Sassen’s Global Cities). This is the case of the widely explored Randstad Holland Polycentric Metropolitan Area, which was identified in the 1960s. These works about polycentric urban structures deal with three key issues (Lambregts, 2009: 179): “a) the conceptualization and measurement of polycentrism at the metropolitan scale; b) the exploration of social, economic and environmental (dis)advantages related to polycentrism at the metropolitan scale; c) the planning and governance challenges that relate to polycentrism at the metropolitan scale”.

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1 See for instance the special issues about this topic in journals such as ‘Built Environment’ (issues 31(2) in 2005 and 32(2) in 2006), ‘European Planning Studies’ (issues 6(4) in 1998 and 12(3) in 2004), ‘Urban Studies’ (issue 38(4) in 2001) or ‘Regional Studies’ (issue 42(8) in 2008) as well as the seminal works of Hall and Pain (2006) or Meijers (2007) and ESPON 2006 Projects concerning polycentric spatial structures (such as ESPON Project 1.1.1 - Urban areas as nodes in a polycentric development or ESPON Project 1.1.3 - Enlargement of the EU and its polycentric spatial structure).

2 Comprised by the core cities of Amsterdam, Rotterdam, The Hague and Utrecht and several medium-sized cities.
Today, the debate on polycentric spatial developments has acquired a crucial role as a planning strategy to contribute to a more balanced regional development by reducing regional disparities and to promote sustainability, territorial and social cohesion and competitiveness by fostering the integration of European regions into the global economy (EC, 1999; ESPON, 2004). In the European policy context, the European Spatial Development Perspective (ESDP) policy document suggests that “the concept of polycentric development has to be pursued, to ensure regionally balanced development, because the EU is becoming fully integrated in the global economy” (EC, 1999). National and regional governments are also paying increasing attention towards the potentialities of polycentrism to achieve cohesion and to enhance urban competitiveness (Meijers et al., 2012).

These emerging urban systems, in which the traditional monocentric model becomes more polycentric and peripheral communities (suburban centers) start acquiring a greater relevance within the settlement structure, are leading to the blurring of the historical rural-urban dichotomy (Soja, 2005). Apart from this spatial transformation, urban systems have also witnessed considerable functional readjustments, partly benefited from transport network improvements. On the one hand, an increase on mobility levels has taken place. On the other, because the metropolitan center has lost its primacy (or in some cases, it is in the process of reducing it), functional relations are no longer only hierarchical and unidirectional towards it. Conversely, they become multidirectional and spatially discontinuous between the traditional principal city and its wider surrounding territory and within these more distant areas (Parr, 2005; van der Laan, 1998; Gutiérrez and García, 2006; de Goei et al., 2010). Altogether, these new spatial configurations meant a conceptual change from traditional interpretations of the city (as a single center surrounded by a rural hinterland) towards more regionalized ones (that consider a wider territory covering increasingly interlinked historically freestanding urban and suburban communities).

According to Champion (2001), different types of polycentric metropolitan areas (or degrees of polycentrism) may be distinguished regarding the evolution of their spatial structure and the presence (or not) of a dominant city (see Figure 1.3.). On the one hand, areas featured by a dominant city overflowing its influence over a larger territory and incorporating distant small and medium-size cities (the ‘centrifugal’ and ‘incorporation’ modes). This is the case of London or Paris. On the other hand, territories where freestanding cities coalesce/cluster to form a polycentric metropolitan area (the ‘fusion’ mode). This is the case of regions such as the Randstad in the Netherlands, or the Flemish Diamond in central Belgium. The main difference between these two types of polycentric metropolitan areas is in terms of hierarchy. Whereas the fusion mode results in more balanced regions, the incorporation one leads to large city-regions dominated by a single core (Hall and Pain, 2006; Meijers and Burger, 2010; Meijers et al., 2012). This difference emphasizes that, in contrast to the theoretical prototype of ‘Polycentric Urban Region’¹ (Kloosterman and Musterd, 2001) such as the abovementioned remarkably studied in central Europe, “there are many clusters of close-by cities in which there is strong

¹ Defined as a collection of historically distinct cities located in more or less close proximity (commuting distance) and with a balanced distribution of size (Kloosterman and Musterd, 2001).
potential for improved performance, but that may not have materialized yet due to a variety of barriers that need to be overcome" (Meijers et al., 2012: 17). In these multicentric metropolitan areas, together with the metropolises, a set of metropolitan intermediary cities (composed by a selective group of new employment centers and of historic cities) shape an emerging global multicore-network at metropolitan-regional scale.

Moreover, polycentric urban networks can be identified at two different scales: a) intra-metropolitan polycentrism, as a result of the generation of new centers (Richardson, 1988; Garreau, 1991) and the reinforcement of the industrial poles of the first industrialization process (Roca et al., 2012); and b) supra-metropolitan polycentrism, as a result of the integration of new metropolitan regions, whether by coalescence of spaces in different provinces/regions, as in the Randstad (Netherlands) or Rhine-Rhur (Germany) (Kloosterman and Musterd, 2001; Meijers and Romein, 2003; Hall and Pain, 2006), or by the extension of the metropolitan influence over close systems of small and medium-sized cities (Roca et al., 2012).

On top, either polycentric or multicentric urban structures, all the recent researches point to the city as a regional phenomenon and agree that we are living in ‘a regional world’ (Storper, 1997) characterized by an emerging spatial form in which a set of close-by and strongly interconnected medium-sized cities surrounding the metropolitan center starts acquiring greater relevance within the metropolitan urban system (Scott et al., 2001; Lambregts, 2009; Meijers et al., 2012). Nevertheless, quoting Lambregts (2009:16), "polycentrism is typically ‘in the eye of the beholder’: its manifestation changes with the spatial scale of analysis, the functions looked at and the relationships explored”. This results in polycentrism remaining as a "versatile and ‘fuzzy’ concept" (Burger and Meijers, 2012: 1127).

First, there is lack of an agreed clear and consistent term. Scholars have already called such clusters of cities as ‘networked cities’ (Batten, 1995), ‘Regional City’ (Calthorpe and Fulton, 2001), ‘Polycentric Metropolis’ (Lambregts, 2009), ‘Polycentric Urban Region’ (Kloosterman and Musterd, 2001), ‘Polycentric Mega-city-Region’ (Hall and Pain, 2006), ‘Mega-Regions’ (Florida et al., 2008) or ‘Global City Region’ (Scott, 2001). Despite the inexistence of a unique term, all of them refer to spatial configurations characterized by externalities not confined to a single urban core but shared among a collection of close and linked cities. As previously mentioned, whereas the lack of hierarchy and of a clear leading city has been extensively considered as a defining feature of polycentric systems (Kloosterman and Lambregts, 2001; Parr, 2004), concepts such as ‘multicentric’ or ‘multinuclear’ have recently appeared. They refer to those areas where the balanced distribution (in terms of size) of the multiple urban centers is not so clear (Burger and Meijers, 2012).

1 This is a more accurate term to describe these urban configurations with a still predominant principal city.
2 Hence, the city is no longer an appropriate unit of analysis, since it does not adequately reflects the underlying structure of economic and social organization (Parr, 2005).
Second, it is also questionable whether polycentrism refers to only morphological aspects, in terms of size and territorial distribution (Parr, 2004; Meijers and Burger, 2010), or to relational ones, regarding functional connections between the centers and the strength of these interactions (ESPON, 2004; Green, 2007; de Goei et al., 2010). In order to clarify why some systems are morphologically but not functionally polycentric, or vice versa (see Figure 1.1.), some scholars have recently suggested a combination of both dimensions (Hall and Pain, 2006; Hoyler et al., 2008; Burger and Meijers, 2012).

Third, regardless of adopting a morphological and/or a functional dimension, different approaches have been proposed to identify and measure polycentrism. According to Champion (2001), the most problematic issues would appear to be: a) the spatial scale; b) the degree of interaction between centers that is needed to reject considering urban centers as part of a single larger urban region; c) the variety of origins out of which a polycentric urban region can emerge; or d) the different development trajectories they have followed and their points of departure (see Figure 1.3.).

Figure 1.1. - Morphological versus functional polycentrism. Source: Burger and Meijers, 2012.

Four, there are greatly diverging interpretations of what makes such territories polycentric. In these emerging spatial reconfigurations (the ‘post-metropolitan transition’) cities and metropolitan regions worldwide have experienced since the 1970s, three interrelated factors have been identified as driving forces: a) the transition from an industrial/fordist to a post-industrial/post-fordist and the introduction of more flexible modes of production; b) globalization and economic/political-institutional restructuring as well as changes in technological processes; and c) the revolution of Information and Communication Technologies (Storper, 1997; Scott et al., 2001; Soja, 2005; Kloosterman and Lambregts, 2007; Meijers et al., 2012).

1 "The question to what extent a region displays evidence of polycentrism is often first addressed by looking at the region’s urban morphology. Rank-size indices based upon population data have been used (Hall and Pain, 2006), as well as location indices (ESPON, 2006)” (Lambregts, 2009:11).
From a spatial perspective, debates on the emergence of polycentric metropolitan spatial configurations are closely related to transport developments (Taaffe, 1962; Haggett, 1976; Helbich and Leitner, 2009). A special consideration has been paid to road and highway networks due to their capabilities: a) to diminish time distances, bringing distant territories closer together (the so called ‘time–space convergence’ and ‘time-space compression’ phenomenon first introduced by Janelle, 1968), and allowing an expansion of potential catchment areas and a scale shift of the traditional metropolitan area (Rodrigue et al., 2009; García-López, 2012); b) to facilitate economic activities decentralization and residential dispersion, leading to the appearance of new centers in metropolitan peripheral locations (taking advantage of high accessibility levels, closeness to the center and lower land prices) and consequently to the emergence of new polycentric urban structures (Berry, 1959; Gutiérrez, 1992; Lowe, 1998; García and Gutiérrez, 2007).

This undeniable relationship between transport networks and settlement structures has been extensively studied from many points of view: a) the scale shift and enhancement of externality of metropolitan influence, progressively integrating wider areas; b) the settlement structure transformation, with phenomena like urban sprawl and re-location of economic activities; c) the evolution of the internal functional relations, mainly derived from the increasing interaction within urban networks; d) the new economic patterns resulting from specialization and complementary processes; and e) the application of more rational principles for land-use planning and decision-making. Improvements in transport networks have thus facilitated the emergence of a new urban model, in which residences and workplaces don’t answer to the same location logic (Monzón and de la Hoz, 2009) and in which minimizing distances is not the one and only factor in deciding residence/work locations (Sohn, 2005). In conclusion, the new territorial polycentric urban model cannot be separated from the transformation of the traditional radial transport networks into radio-concentric ones.

2. RESEARCH JUSTIFICATION

As already mentioned, facilitated among others by improved communication and transportation systems, during the last decades traditional Metropolitan Areas have witnessed a conspicuous expansion, overflowing towards their adjacent rural regions. The ‘Extended Polycentric Urban Regions’ (see Figure 1.2.) are spanning further away from the metropolitan center and beyond their traditional

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1 Particular attention has been paid to the new orbital infrastructures (mainly motorways) that are being built around the central core of metropolitan regions allowing peripheral relationships and increasing accessibility of the outskirts (Linneker and Spence, 1992; Gutiérrez and Gómez, 1999).

2 Access to transport services as well as employment opportunities can also be very important for the way the consequences of the commute are perceived. If there is good access to fast, comfortable and flexible means of transportation, people are more willing to accept a longer commuting distance.

3 A conceptual distinction is made hereby between the terms ‘area’ and ‘region’: the latter refers to administrative regions, i.e., the territorial units (with marked boundaries) into which a country is divided.
peri-urban areas\(^1\) (which are defined as the transition zone between urban and rural areas and characterized by a dispersed and non-contiguous fabric of metropolitan center’s built-up areas). This scale shift results in the functional integration of freestanding surrounding medium-sized cities into the metropolitan dynamics. It is therefore necessary to address the challenges of the new ‘Extended peri-urban area’ at the wider strategic level of the surrounding ‘Rural-Urban region’ which comprises the urban area, the peri-urban area and the rural\(^2\) hinterland (Piorr et al., 2011).

Whereas the discussion about the current spatial global challenges and the recent reconfiguration of urban systems has constituted a central role of analysis since the last years of the 20\(^{th}\) century, debates are mainly focused on large capital, primate and global cities (Bell and Jayne, 2009; van Heur, 2010; Cardoso and Meijers, 2013). Hence, in depth analyses within these extended territories are needed, particularly to understand changes taking place in recently reconfigured rural regions adjacent to traditional metropolitan areas and increasingly becoming integrated in metropolitan processes. The term ‘rural metro-adjacent region’ (see Figure 1.2) is used within the limits of this thesis dissertation to define these specific administrative territorial units.

The relevance of focusing on rural areas is twofold. First, because of their considerable spatial extension (in 2007 in the EU-27, rural areas represented 91% of the territory and 59% of the population) which have led to the increasing consideration they are recently receiving in European policies. Second, because of the multiple transformations they have witnessed in recent years such as a rural population ‘turnaround’, a reconfiguration of rural commuting, new production dynamics, the integration of the rural dimension with national society or changes in the cultural dimension (Ortiz-Guerrero, 2013). More specifically, rural metro-adjacent regions are an especially interesting research topic because they are hybrid territories that are neither fully integrated into metropolitan dynamics nor totally rural and self-contained. Metropolitanization processes and the rescaling of states have been, among others, crucial in these transformations within rural metro-adjacent regions.

\(^1\) Peri-urban areas are defined for the PLUREL project as: ‘discontinuous built development containing settlements of each less than 20,000 population, with an average density of at least 40 persons per hectare (averaged over 1km cells)’ (Piorr et al., 2011).

\(^2\) There is no single internationally accepted definition for ‘rural’ areas. In 2009, the OECD Working Party on Territorial Indicators (WPTI) approved and adopted the following regional typology (OECD, 2011): Predominantly Urban (PU), Intermediate Close to a city (INC), Intermediate Remote (INR), Predominantly Rural Close to a city (PRC) and Predominantly Rural Remote (PRR). According to this, rural regions (the last two types) are those ones characterized by a share of population living in rural local units (administrative entities with a population density below 150 inhab./km\(^2\)) higher than 50%. A distinction between the two types of rural regions is made regarding the percentage of the regional population that is within 60 min driving time from the closest locality with more than 50,000 inhab.
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Metropolitan center                         New Employment Center*                         Historic Administrative City                         Functional relationship

*Different terms have been used in literature to describe these New Employment Centers: edge cities, technoburbs, metropolitan sub-centers, commuter towns, suburban activity centers or suburban downtowns.

Figure 1.2. - The Extended Polycentric Metropolitan Area/Urban Region. Source: the author.

A special attention is needed to be paid to rural metro-adjacent regions’ medium-sized or secondary cities because of their economic potential to evolve even more dynamically than large metropolises (Hodos, 2011; Cox, 2012; ESPON, 2012; OECD, 2012) and their role as ‘essential spatial nodes’ and ‘engines’ of today’s global economy (Lambregts, 2009). Nonetheless, despite their increasing relevance in global economy, up to now, little emphasis has been paid to small and medium-sized cities within the new Extended Polycentric Urban Region.

3. AIM AND RESEARCH HYPOTHESES

The aim of this thesis dissertation is to understand urban reconfigurations within rural metro-adjacent regions traditionally characterized as acephalic, leaderless and without internal functional cohesion. A special attention is paid to assess to what extent the scale shift of metropolitan territories (overflowing their influence/effects towards wider areas) and the changes brought about by a state rescaling are conditioning transformations on these regions’ urban configurations and functional coherence. The main objective is thus to characterize morphological and functional changes within the new peri-urban areas of Extended Polycentric Urban Regions (see Figure 1.2.) in order to assess the
effects of metropolitan influence overflows. By broadening the analyses to the entire administrative unit in which these extended peri-urban areas are included, it is possible to evaluate the state rescaling effects.

Based on a combined morphological and relational methodological approach (which addresses accessibility and mobility analyses), this thesis aims to propose a useful tool for transport planning, and particularly for the assessment of the territorial impacts generated by infrastructure running through rural metro-adjacent regions. Its application enables the assessment of whether a more cohesive regional urban structure has been/is being consolidated during the last decades in these rural metro-adjacent regions.

Despite the complex set of factors conditioning these transformations, this dissertation pays special attention to transport network developments. Firstly, because rural metro-adjacent regions have benefited, mainly after the rescaling of states, from European structural funds devoted to transport infrastructure investments (following a ‘national-regional’ investment rationale) in order to promote their intra-regional cohesion. Secondly, because they have been considered as one of the main driving forces of these new extended polycentric metropolitan structures.

This analysis of rural metro-adjacent regions’ urban system is set under the following conceptual hypotheses (C.H.).

- **C.H.1.** The first hypothesis that guides this research is that improvements in rural regions’ transport systems, which range from the upgrade of existing links to better quality standards to the provision of new regional tangential infrastructures (developed under ‘national-regional’ investment rationales and complementing the traditional radial network), constitute a driving force of their urban spatial configuration changes. This hypothesis can be broken down in another two. On the one hand, improved transport networks throughout the regional territory result in the extension of catchment areas, allowing greater internal interconnection levels (in contrast to the traditionally predominant functional linkages towards metropolitan areas) and strengthening the emergence of a more polycentric urban structure (which means that rural metro-adjacent regions are overcoming their traditional leaderless character). On the other hand, they facilitate a ‘more balanced development’, reducing regional disparities and consequently fostering internal cohesion. Nevertheless, as a result of competition effects, differences in the infrastructure provision (greatly selective for some networks such as the High-speed Rail one) give rise to different city-profiles.

- **C.H.2.** The second hypothesis posits that the progressive extension of metropolitan influence (overflowing towards rural metro-adjacent regions) is one of the issues behind the increase in mobility in these regions, transforming their predominantly rural character to a hybrid one (even mimicking metropolitan behaviors). Moreover, due to their proximity to the metropolitan
center, these rural metro-adjacent regions are gradually increasing their openness towards other territories and their integration into metropolitan dynamics.

- **C.H.3.-** The third hypothesis sets that, benefited by the downscaling of power state to local/regional governments and, particularly, by the transport system improvements, apart from increasing mobility levels, **rural metro-adjacent regions are witnessing a noteworthy functional reorganization** characterized by some regional centralities acquiring an outstanding role in attracting flows (in contrast to the traditional capabilities of the metropolitan center). These attraction capabilities vary regarding the type of functional linkage.

- **C.H.4.-** The fourth hypothesis is related to the influence of education on the spatial distribution of work-related linkages. This dissertation posits that **concentration of working population on the main regional centralities increases with education** because of: a) the considerable concentration of high-skilled jobs at them; b) the importance given by these talented professionals to urban amenities and quality life; and/or c) the need for face-to-face contacts. Consequently, **highly-skilled professionals living in these regions engage less in commuting (but more in business travel)** than the average working population although, on average, they are more willing to travel further distances.

In addition to the four abovementioned conceptual hypotheses, the following five **methodological hypothesis (M.H.)** guide this dissertation:

- **M.H.1.-** The first methodological hypothesis is that a **diachronic combined/sequential and multimodal accessibility approach constitutes an accurate tool to understand urban structure transformations** within rural regions highly influenced by metropolitan processes and to capture three key urban processes: a) interconnection and extension; b) potential for interaction and cohesion; and c) specialization and city-profile among centers. Accessibility indicators also enable the evaluation of the coherence/feasibility of their infrastructure investments in promoting (internal) competitiveness.

- **M.H.2.-** Since the change from a national transport investment rationale to a combined ‘national-regional’ one (which fosters the development of regional transport infrastructures) has been partially favored by the downscaling of state power towards the regional and local levels, the second methodological hypothesis, closely related to the previous one, poses that **the analysis of accessibility changes brought about by these tangential connections is a good first approximation to the state rescaling effects.** The previously hypothesized fostered intra-regional cohesion and strengthen regional centralities is reflected in the increasing supply of interconnections within the regional territory (in contrast to those occurring with the metropolitan center and sub-centers).

- **M.H.3.-** The third methodological hypothesis sets that by assessing **workers’ housing locations** and their willingness to undertake work-related travel, it is possible to examine the regional
spatial concentration, the reinforcement of some places as residential centers and whether different distributions of the working population could be observed with respect to education levels.

- **M.H.4.** Since recurrent work-related flows (commuting) have constituted for a long time the majority of all daily trips, the fourth methodological hypothesis proposes that their spatial distribution is a useful data when investigating urban spatial structures. Additionally, their diachronic study over time, in terms of changing capabilities for emitting/attracting commuting trips, allows depicting urban structure reconfigurations and changes in the degree of regional self-containment and isolation of recently rescaled rural metro-adjacent regions (internal cohesion) in contrast with the articulation into metropolitan dynamics (openness to other territories). The selection of the assessed time scenarios, before and after a specific event or project, enables as well the understanding of their effects on these regions’ urban transformations. In this research, by comparing the present situation with that previous to the Spanish state re-scaling process, the significant transformation of metropolitan contexts (from monocentric to polycentric models), the proliferation of motorways (developed under ‘national-regional’ rationales -which seek articulating the entire regional territory and fostering intra-regional linkages- in contrast to the previous national ones) and the construction of the High-Speed Rail network (hereinafter HSR), the two temporal scenarios allow capturing the effects of metropolitan extension and state rescaling.

- **M.H.5.** The fifth methodological hypothesis argues that because regional cohesion and reinforcement of a specific set of centers may vary with regard to the type of linkage and to workers’ education and occupation, by taking into account ‘travel purpose multiplexity’ (commuting versus business travel) and ‘individual level heterogeneity’ (average working population versus highly-skilled professionals), misleading conclusions in regards to the functioning of the underlying urban system are avoided.

In relation to the research aim and hypotheses, the following issues are addressed:

a) A review of the already proposed approaches to measure changes in spatial structures, establishing a theoretical framework of their advantages and limitations. This detailed literature review reveals the gaps of previous studies and enables the definition of the most accurate methodological approach to achieve the aim of the thesis (see section 2.2. of Chapter 2 and sections 2.2. and 3.2. of Chapter 3).

b) An evaluation of changes in accessibility patterns brought about by (multimodal) transport network improvements (Chapter 2). Particularly,

- The scale shift in the settlement system which means the increasing of daily reachable spaces and nuclei and in some cases resulting to discontinuous catchment areas (as it happens with HSR networks).
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- The combined effect of land-use distribution and transport components in addition to individuals’ perceptions of transport (with a distance decay function) on the potential for interaction of the regional territories.

- The effects of competition in the performance of those centers leading the rural metro-adjacent regions urban network.

c) An assessment of evolving commuting patterns (Chapter 3.2.), paying attention to:

- Changes in main centralities’ capabilities for emitting/attracting journey-to-work trips to evaluate adjustments in: a) regional cohesion (in terms of commuting relations within the rural metro-adjacent region); b) articulation with metropolitan territories (in terms of commuting relations with the Metropolitan Region); c) integration in national/global processes (in terms of commuting relations to external territories excluding the Metropolitan Region on which they are highly dependent).

- Factors influencing changes in the out-commuting patterns of the main regional urban system.

- Prevailing out-commuting relations of all municipalities within the study area and their destination to clarify autonomy or dependency of rural metro-adjacent regions’ Functional Urban Areas.

d) An analysis of the extent to which travel purpose and education influence on the spatial distribution of functional linkages and their implications in explaining the underlying urban structure (Chapter 3.3.). A comparison between the considered travel purposes and differences in regards to education is done by assessing: a) the level of engagement; b) the traveled distances; and c) the destinations/direction of flows.

4. THESIS ORGANIZATION

This thesis is based on three main papers (Papers 1, 2 and 3) and a set of supplementary ones (included in the ‘Appendices’ Section) that support the central research (see Figure 1.4.). The outcomes from these eleven papers (already published or being under review in journals of proved scientific relevance) analyzing the urban and transport networks of recently reconfigured rural metro-adjacent regions, provide the basis for addressing the main research aim.

The dissertation is organized as follows:

• PART I. This introduction section (Chapter 1) presents a framework of the thesis by: a) introducing the research topic and the existing gaps in previous literature; b) summarizing the research justification; b) presenting the research aim and hypotheses; c) contextualizing the case study; d)
proposing the general methodological approach; and e) describing the thesis contributions. Papers A.1 (see Appendix I) and A.2 (see Appendix II) are referred to in this first section, supporting the description of the study area.

As a first approximation to the research topic, Paper A.1: SOLÍS, E., MOHÍNO, I. and UREÑA, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies 23(3):568-596 marked the starting point of the present thesis dissertation. By comparing medium-sized cities with different origins (New Employment Centers\textsuperscript{1} and Historic medium-sized Cities\textsuperscript{2}), the work proposes a characterization of Extended Madrid Metropolitan Region under a double perspective: a) a morphological approach, regarding size, location and socioeconomic evolution criteria; and b) a functional approach, regarding centrality roles, ‘Advanced Producer Services’ (APS) concentration\textsuperscript{3} and spatial articulation capacities of centers in terms of commuting.

One of the main contributions of SOLÍS, E., MOHÍNO, I. and UREÑA, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies 23(3):568-596 is the proposal of an additional mode to explain the evolution of metropolitan spatial structures, called as the ‘blended’ path, to characterize metropolitan regions that have evolved moving along the abovementioned modes described by Champion (2001) (see Figure 1.3.). This is the case of Madrid Metropolitan Region, characterized by (Gutiérrez, 1992, Solís, 2011; Solís et al., 2012): a) a centrifugal growth during the 1980s but that became stronger during the 1990s; b) an incorporation path that started during the 1990s and got stronger during the first decade of the twenty-first century; and c) a fusion path that slowly started during the past decade. In areas resulting from a blended path, despite the metropolitan center is still playing a dominant role, a new multinodal urban structure is emerging characterized by a dual system of cities: a) metropolitan intermediary cities, which are the top medium-sized cities and new globalization anchors; and b) metropolitan cities, which are the remaining medium-sized cities and that connect goods and services between rural areas and the rest of the urban system.


\textsuperscript{1} New Employment Centers (NEC) are centers close to the principal city and with a metropolitan origin that three decades ago were satellite cities, dormitory cities, small towns or new towns.

\textsuperscript{2} Historic medium-sized Cities (HC) are freestanding cities, at further distances from the principal city than NECs, with administrative and/or economic roles in the national urban system progressively integrated in metropolitan processes.

\textsuperscript{3} Advance Producer Services is a cluster of activities that provide specialized services, embodying professional knowledge and processing specialized information, to other service sectors. Such knowledge-intensive services, provided by specialist consultancies, are a central feature of a new post-industrial economy, reflecting an acceleration of technological change based especially on micro-electronics, information and computer technology, new materials and biotechnology (Hall and Pain, 2006:4). By assessing the concentration of APS, metropolitan medium-sized cities’ recent and increasing global economy openness is evaluated.
analyses the role the 'ex-metropolitan' HSR stations within the case study (up to 100 km from the metropolitan center) can play in reinforcing metropolitan integration and their consolidation as economic metropolitan subcenters.

**PART II.** The empirical analyses are presented in the following two sections (Chapters 2 and 3).

On the one hand, **Chapter 2** assesses the integration, interaction and competition capabilities of rural metro-adjacent regions. After a first introduction presenting the theoretical framework and methodological considerations about previous accessibility studies, Chapter 2 presents Paper 1: **MOHÍNO, L., UREÑA, J.M. and SOLÍS, E.** (Mimeo), “Transport Infrastructure and Territorial Cohesion in Rural Metro-adjacent Regions: A Multimodal Accessibility Approach. The Case of Castilla-La Mancha in the Context of Madrid (Spain)”, submitted to Transport Policy (Under review). This paper describes in detail the first step of the proposed methodology to characterize rural metro-adjacent regions’ urban reconfigurations. By addressing a multimodal accessibility analysis (morphological approach), the internal territorial interconnection and cohesion of the case study (and their changes over time) are analyzed in contrast to its outstanding traditional integration into metropolitan dynamics.
This methodological approach was first tested for territories closer to the metropolitan center and for the road network. The results of this already published first test are presented in Paper A.3 (see Appendix III): MARTÍNEZ, H., MOHÍNO, I., UREÑA, J.M. and SOLÍS, E. (2014), “Road accessibility and articulation of metropolitan spatial structures: the case of Madrid (Spain)”, *Journal of Transport Geography* 37: 61-73. Nevertheless, since some limitations were identified in this first approach and due to the need to cover wider territories further away from the metropolitan center (to understand changes in rural metro-adjacent regions accessibility patterns), this previous methodology was refined in Paper 1: MOHÍNO, I., UREÑA, J.M. and SOLÍS, E. (Mimeo), “Transport Infrastructure and Territorial Cohesion in Rural Metro-adjacent Regions: A Multimodal Accessibility Approach. The Case of Castilla-La Mancha in the Context of Madrid (Spain)”, submitted to *Transport Policy* (Under review).

Although it is not the intention of this thesis (which is focused on the transport network supply), Chapter 2 calls attention to the need to take transport services into account in accessibility analyses. A first approach to this issue (still in a very preliminary stage) was presented at the Conference “High speed rail and the city: tourism and dynamics around stations” held by the University of Paris-Est Marne-La-Vallée in January, 2015. This conference contribution has resulted in the elaboration of Paper A.4 (see Appendix IV): MOHINO, I., DELAPLACE, M. and UREÑA, J.M. (Mimeo), “High-Speed Rail Networks and Station Surroundings Valorisation Policies: The case of Cities about 1 hour from Metropolises”, *Submitted to Belgeo (Accepted with major revisions)*.

On the other hand, Chapter 3 presents an exploration of the spatial configuration of functional linkages within these rural metro-adjacent regions. This relational characterization is done in two steps:

- First, by addressing changing commuting patterns within rural regions gradually integrated into metropolitan dynamics and recently reconfigured by state rescaling processes. This diachronic analysis is included in Chapter 3 – Section 2, which presents Paper 2: MOHÍNO, I., SOLÍS, E. and UREÑA, J.M. (Mimeo), “Changing Commuting Patterns in Rural Metro-Adjacent Regions: the case of Castilla-La Mancha (Spain)”, *submitted to Regional Studies (accepted with minor revisions)*. Additionally, this section refers to a first approach to the redistribution of work-related functional linkages carried out based on own-elaborated mobility surveys. This preliminary analysis is gathered in Paper A.5 (see Appendix VI): MOHÍNO, I., UREÑA, J.M. and SOLÍS, E. (InPrint), “Patrones de Movilidad en Áreas Distantes de Regiones Metropolitanas Multicéntricas: Radialidad vs. Tangencialidad. El Caso de Castilla-La Mancha Respecto a la Región Metropolitana Madrileña”, *Boletín de la Asociación de Geógrafos Españoles* 69 (pages not available yet). It was the publication of official statistics on commuting what encouraged the authors to improve the analyses (resulting in the elaboration of Paper 2).

- Second, by examining differences between the spatial patterns of commuting and business travel in rural metro-adjacent regions. These patterns are also compared for different working population profiles regarding their education level, to investigate how rural metro-adjacent regions

PART III. The last part of the dissertation presents its concluding remarks and various lines for future research. This section emphasizes two issues that need to be tackled in future research and that to some extent have already been addressed by the author although without in depth consideration. On the one hand, ‘non-compulsory’ travel purposes, which should be incorporated in the relational analyses of rural metro-adjacent regions. Based on own-elaborated mobility surveys for the considered case study, a preliminary comparative analysis of commuting, business, shopping and access to health services was presented at the ‘9th European Urban and Regional Studies Conference - Europe and the World: Competing Visions, Changing Spaces, Flows and Politics’ held at University of Sussex in July, 2013. The conference paper is included in Paper A.7 (see Appendix IX): MOHINO, I., UREÑA, J.M., SOLÍS, E. and MARTÍNEZ, H.S. (2013), “Distant areas of multicentric metropolitan regions households’ functional relationships: radial versus tangential mobility patterns”, 9th EURS Conference, University of Sussex, 10-12 July, 2013. On the other hand, the sustainability of urban and transport systems by looking at rural metro-adjacent regions’ modal split. Based as well on own-elaborated mobility surveys for the considered case study, a preliminary comparative analysis of modal split in regards to travel purpose and education level was presented at the ‘High speed rail and the city: tourism and dynamics around stations’ Conference held at the University of Paris-Est Marne-La-Vallée in January, 2015. This conference paper is included in Paper A.8 (see Appendix X): MOHINO, I., UREÑA, J.M. and SOLÍS, E. (In Print) “The influence of education on work-related travel in rural metro-adjacent regions: the case of Castilla-La Mancha (Spain)”, The Open Transportation Journal.

As this dissertation is the result of a collection of papers with a common argument and which are applied to the same case study, some overlaps may be found along the document. Although these parts could have been rewritten to avoid repetitions, the desire was to keep the papers in their original versions1. For that reason, a general ‘Framework and case study’ section is included in this first part/chapter of the dissertation, suggesting the reader to skip each paper’s case study description.

1 Either the ones already published or the ones submitted to the journals. Only sections/subsections and figures have been named consecutively to make the reading easier.
Figure 1.4. - Structure of the thesis. Source: the author.
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5. FRAMEWORK AND THE CASE STUDY

In Spain, the reconfiguration of political administration and the creation of the Autonomous Communities (Administrative Regions) that took place during the 1980s have been crucial in spatially reconfiguring urban networks and in fostering rural differentiation. This decade was also the starting point of a noteworthy transport system change, not only around the main urban centers (by the densification of the road network) but also within the least favored regions (by the extension of the motorway network and the proliferation of HSR plans executed during the following decades). These transport network improvements were favored by a transition in the investment rationale, from a ‘national’ perspective (which traditionally aimed to connect the main national urban centers, conditioning the ‘passing-through’ character of transport infrastructures within inland regions) towards a ‘national-regional’ one (which gives more relevance to the articulation of medium-sized cities, fostering intra-regional linkages).

This dissertation covers two of those reconfigured inland Spanish administrative regions (Figure 1.5.): the Castilla-La Mancha (hereinafter CLM) rural region adjacent to the Madrid metropolitan one, created in 1982 and 1984 respectively. The relevance of focusing on CLM lies in the fact that it is one of the only two Spanish regions that are simultaneously characterized by their rural character and by their adjacency to a metropolitan area. While central Spain has been the subject of recent studies and debates, most of them have constrained their analyses to the Madrid Region (Gallo et al., 2010; García, 2010), being very limited those considering the CLM region (Pillet et al., 2010, 2014). However, they fail in considering their study areas in an isolated manner forgetting about interactions between the two regions. Only a few recent works examine the Madrid region and more distant provinces outside it (Solís et al., 2012; Romero et al., 2014) although none of them covers the entire CLM region.

Among this last group of works, it is remarkable the one by Solís, E., Mohíno, I. and Ureña, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies 23(3):568-596 (see Appendix I) which marked the starting point of the present thesis dissertation and a first approximation to the research topic. Initially concerned about the potential of medium-sized or secondary cities as ‘engines’ of today’s global economy (Lambregts, 2009), the little emphasis that up to now has been paid to these cities within the new Extended Polycentric Urban Regions (see Figure 1.2.) motivated the PhD candidate and her two thesis supervisors to develop a more critical analysis of them. Based on a combination of morphological and functional aspects, this work proposed a characterization of the Extended Madrid Metropolitan Region under a double morphological and functional perspective. But whereas this previous study constrained to the five adjoining provinces of the CLM (Cuenca, Guadalajara and Toledo) and Castilla y León Administrative regions (Ávila and Segovia), the need to extend the analyses towards the entire rural metro-adjacent region was identified. These extended analyses would allow the evaluation of the
role the state rescaling and the derived new administrative boundaries have played on urban configuration, assessing differences in regards to proximity to the metropolitan center.

Figure 1.5 - Study Area: the Madrid and Castilla-La Mancha regions (Year 2012). Source: the author.

The analyses span over the last three decades: from 1981 (to understand the situation before the Spanish state rescaling process that took place in Spain during the 1980s) up to 2012 (to visualize the current situation). Apart from a regional urban spatial reconfiguration (the creation of the Administrative Regions, the emergence of new employment/economic sub-centers and the integration of historic cities into the spreading metropolitan region which overflows beyond the Madrilenian boundaries, the allocation of the CLM regional capital in Toledo, etc.), a noteworthy transport network change occurred during this period (characterized by the consolidation of a radio-concentric transport

1 Leading poles are medium-sized intermediary cities (defined by SOLÍS et al., 2015 as centers between 20,000 and 250,000 inhab.) with a conspicuous potential in organizing the area, greater interaction capabilities (potential accessibility) than the regional averages and an outstanding competition for opportunities with each other. Madrilenian Leading Poles are cities with more than 40,000 inhabitants in 2010 and more than 20,000 employees in 2007 (that is, the ‘Employment centers’ identified by Romero et al., 2014).

2 CLM Leading Poles are defined in this thesis as those cities with more than 15,000 inhab. and 2,500 jobs in 2012.
system in the close proximity of the metropolitan center in addition to the traditional radial one\(^1\) and by the construction of some tangential infrastructures within the CLM region\(^2\)).

In this case study, the Madrilenian region exerts a crucial role. Its traditional metropolitan area has evolved from a compact and monocentric/centralized urban configuration towards a more sprawling and polycentric one (Heitkamp, 2000), showing an expansion process during the last few decades beyond the metropolitan boundaries delimited in 1963 (Cin \textit{et al.}, 1994; López, 2003). This emerging polycentric urban configuration is been consolidating since the 1970s\(^3\), although territorial transformations have been more noticeable since the late 1980s and 1990s motivated by its transport network growth, by the outstanding increase in motorization indices and by population/economic decentralization processes (García and Gutiérrez, 2007). This led to the emergence of new sub-centers and the integration of historic cities and consequently to the expansion of the metropolitan influence beyond the Madrid Administrative Region (Feria and Alberto, 2010; Roca \textit{et al.}, 2012; Solís \textit{et al.}, 2012; Sanz and Vizcaíno, 2014). As a result, mobility has acquired complex patterns and functional interrelations have been developed in the neighboring provinces of two different metro-adjacent ‘rural regions’: CLM and Castilla y León (SOLÍS, E., MOHÍNO, I. and UREÑA, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies 23(3):568-596 - see Appendix I).

It is not clear from literature which term best describes the Madrilenian urban configuration. Should it be described as an agglomeration, as a metropolitan area, as a metropolitan region or as an urban region? Whilst it is not the intention of this dissertation to go into detail about these conceptualizations, the term \textit{Madrid Polycentric Urban Region} is adopted in this thesis dissertation.

- Firstly, it is polycentric because of the obvious interweaving of the metropolitan system and the national urban system around it, which is led by medium-sized cities not previously integrated in metropolitan processes. Hence, together with the metropolitan center, the emerging metropolitan intermediary cities, composed by a selective group of New Employment Centers and Historic cities, shape and emerging global multicore network at metropolitan-regional scale.

- Secondly, the reason why Urban Region is proposed is twofold. On the one hand, because of the outstanding extension of the Madrilenian influence overflowing its administrative boundaries. On the other, since according to OECD (2011), Madrid Administrative Region/province is a Predominantly Urban one (in which rural population accounts for less than 15%).

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\(^1\) Changes comprised the construction of four new orbital motorways (M-30, M-40, M-45 and M-50) in the metropolitan center surroundings and the improvements of the subway and commuter rail networks; the upgraded of radial (conventional) roads (originated at the national capital) to motorways standards and the duplication of radial motorways in several corridors (northeast, southeast, south and southwest).

\(^2\) Such as the three tangential motorway stretches (CM-42, A-43 and A-40) or the four radial national HSR lines connecting Madrid and the capital cities of CLM which allow with some tangential connections between the regional territories (others are possible but no services have been implemented yet).

\(^3\) The population distribution evolution between 1960 and nowadays shows the dismantling of the monocentric model. This evolution is characterized by an increased importance of the metropolitan center (Madrid municipality) during the first study years 1960-1970 (from 56% in 1961 to 62% in 1970) and a progressive reduction since then (52% in 1981 to 40% in 2011).
It is of relevant importance to avoid misleading this term with that previously used for those urban systems characterized by historically distinct cities with no clear leading city (regarding size and political/economic/cultural aspects) (Kloosterman and Musterd, 2001). In that sense, whereas a polycentric urban configuration is emerging, at least in regards to functional flows (Solís, 2008, Gutiérrez and García, 2010; Valenzuela, 2010), the fact that the Madrid metropolitan center still maintains a dominant role in terms of political centrality (as the national capital) and population/employment size\(^1\) (see Tables 1.1. and 1.2. and Figure 1.6.a. and 1.6.b.) makes it inappropriate the comparison with the most genuine Polycentric Urban Regions (such as the Randstad Holland).

Nonetheless, it is the adjacent CLM region the central focus of this research (although the Madrilenian one will be present in the arguments/assessments throughout this dissertation). Located between 40 km and 300 km from the municipality of Madrid, CLM is a European ‘Objective 1’ rural region (OECD), with low population density (26.4 inhab/km\(^2\) in 2012) that predominantly comprises municipalities of less than 2,000 inhabitants, i.e. 78.8% in 2012 (see Table 1.1.). However, half of the population (55.6% in 2012) is concentrated in 39 municipalities with more than 10,000 inhabitants (see Table 1.1.). Only seven municipalities are between 50,000 and 175,000 inhabitants: the five provincial capitals, Talavera de la Reina and Puertollano (see Figure 1.5.). Job distribution follows a similar spatial pattern than population (see Figure 1.6. and Table 1.2.).

<table>
<thead>
<tr>
<th>Municipalities</th>
<th>Madrid Region</th>
<th></th>
<th>Castilla-La Mancha Region</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pop.</td>
<td>No. muni.</td>
<td>Pop.</td>
<td>No. muni.</td>
</tr>
<tr>
<td>&lt; 2,000 inhab.</td>
<td>82,103 (1.7%)</td>
<td>46,342 (0.7%)</td>
<td>385,212 (23.7%)</td>
<td>313,789 (14.8%)</td>
</tr>
<tr>
<td>2,000 – 10,000 inhab.</td>
<td>140,537 (3.0%)</td>
<td>32,564 (5.0%)</td>
<td>580,119 (35.7%)</td>
<td>627,853 (29.6%)</td>
</tr>
<tr>
<td>10,001 – 50,000 inhab.</td>
<td>266,442 (5.6%)</td>
<td>36,836 (10.1%)</td>
<td>314,443 (19.3%)</td>
<td>566,247 (26.7%)</td>
</tr>
<tr>
<td>50,001 – 100,000 inhab.</td>
<td>325,753 (6.9%)</td>
<td>73,827 (11.4%)</td>
<td>229,945 (14.4%)</td>
<td>441,527 (20.8%)</td>
</tr>
<tr>
<td>100,001-1,000,000 inhab.</td>
<td>723,654 (15.3%)</td>
<td>14,963 (23.0%)</td>
<td>117,126 (17.2%)</td>
<td>172,472 (8.1%)</td>
</tr>
<tr>
<td>&gt;1,000,000 inhab.</td>
<td>3,188,297 (67.4%)</td>
<td>3,233,527 (49.8%)</td>
<td>0 (0%)</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Total</td>
<td>4,726,986</td>
<td>178</td>
<td>6,498,560</td>
<td>179</td>
</tr>
</tbody>
</table>

In red, a decrease either in the population and the number of municipalities included in the category. In green, an increase in at least one of them. In brackets, the number of inhabitants/municipalities out of the total for each region included in each category.

(*) Ciudad Real, Guadalajara, Talavera de la Reina and Toledo; (**) Albacete; (***) Ciudad Real, Cuenca, Guadalajara, Puertollano, Talavera de la Reina and Toledo.

Table 1.1. – CLM and Madrid Regions’ population change regarding municipal demographic size. Source: the author (based on INE).

\(^1\) With a population of 3.2 million inhabitants in 2012, the Madrid municipality contained in its influence area 39 medium-sized cities (nuclei of between 20,000 and 250,000 inhabitants), being 18 of them characterized as ‘employment centers’ (cities with more than 40,000 inhabitants in 2010 and more than 20,000 employees in 2007) (see Figures 1.5. and 1.6.a. and Tables 1.1. and 1.2.).
### Table 1.2. - CLM and Madrid Regions’ employment change. Source: the author (based on INE and Social Security Data).

Despite this CLM urban structure (not relevant in terms of population size and irregularly distributed throughout the regional territory), since the 1980s the region witnessed a considerable population growth and a centralization process towards the five capital cities (see Table 1.1.), motivated by the location of public and administrative services at them as a result of the state rescaling. Recent studies have accounted for an incipient CLM polycentric urban structure: i.e. Pillet et al. (2014) identified 10 Functional Urban Areas (FUAs), organized by 11 FUA centers, which constitute the main CLM urban structure, and another 15 Dependent Areas on the 10 FUAs.

Divided into five provinces with Toledo as its regional capital (see Figure 1.5.), CLM has traditionally been defined as a disorganized, acephalic/leaderless region that lacks functional cohesion and that is conspicuously functionally dependent on Madrid Region and other Mediterranean urban areas (Cebrián and Cebrián, 2000; Prada and Méndez, 2010). One of the determinants of the CLM urban spatial configuration and dynamics has been the national ‘passing-through’ character of its transportation infrastructures. Recent investments\(^1\) following a ‘national-regional’ rationale established after state rescaling have improved road and rail networks within the region, although they remain preponderantly radial (all its provincial capitals are connected to Madrid by motorway and HSR) with only a few intra-regional tangential infrastructures (three motorway stretches and low-frequency regional conventional rail/HSR connections) (see Figures 1.7., 1.8. and 1.9.).

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\(^1\) As a European ‘Objective 1’ region (OECD), CLM has received considerable European Structural Funds which aim to attain economic and social cohesion of lagging regions by, among others, the development of transport infrastructures.
Figure 1.6. - **Fig.1.6.a. (Above)** Spatial distribution of population (1981-2012). **Fig.1.6.b. (Below)** Spatial distribution of employment (1981-2012). *Source: the author (based on INE statistics and Social Security Data).*
Apart from this meaningful radial character of the CLM road and railway transport infrastructures, a diachronic connectivity analysis (between 1981 and 2012) showed on the one hand, better road network connectivity patterns (and therefore a higher cohesion of the regional territory) not only brought about by the construction of new corridors (the number of edges of the graph has kept nearly constant during the past three decades) but especially by the better features of the existing ones. Analyzing in detail the distribution of the graph edges regarding the type of road, in 1981 the weight of 'national roads' was bigger than of 'motorways' (87 edges against 22, respectively) while in 2011 the figure was completely inverted (32 edges against 124, respectively). That is to say, connectivity changes have a qualitative rather than a quantitative character: motorways are a new paradigm in the regional road system.

![Figure 1.7. - Road network. Years 1981 (left) and 2012 (right). Source: the author.](image)

On the other, the diachronic connectivity analysis showed the tree-shape railway network (see Figure 1.8.), a pattern that has kept constant in the last 30 years, with a low availability of horizontal connections (between CLM cities). The conventional rail network has become more selective due to the reduction in the number of railway stations (in 1981 there were 86 stations while in 2012 the figure decreased to 57): only some municipalities with a certain politico-administrative centrality within the

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1 In order to understand the spatial configurations of rural metro-adjacent regions, a three step methodology based on connectivity, accessibility and mobility analyses was initially proposed. The Conference paper MOHINO, I., UREÑA, J.M., SOLÍS, E. and MARTÍNEZ, H. (2012) “Radial vs. Tangential Transport Networks and Services and their Role in Metropolitan Spatial Structures: the Central Area of Spain as a Case Study” EURA CONFERENCE 2012: Urban Europe - Challenges to meet the urban future, Vienna, 21-23 Sept, 2012, gathers some of those preliminary results. However, the connectivity indicators disregard demographic, political or socioeconomic factors, which are taken into account by accessibility measures. This is the reason why connectivity analyses were finally excluded from the methodology.

2 Such as the new (East-West and Northwest-Southeast) high-capacity corridors which have been projected under a ‘national-regional’ rationale, connecting main CLM cities (see Figure 1.7.).

3 The average degree in both, 1981 and 2011, is 2 and the clustering coefficient is 0 in both cases.
urban network and specific socioeconomic dynamics have kept their train stations. Similar findings are concluded by analyzing rail services, having the supply of services been reduced since 1981 (the number of edges of the graph has fallen from 244 in 1981 to 178 in 2012) and tend to concentrate in a lower number of stations.

**Figure 1.8.** - Conventional rail network (morphology). Year 1981 (left) and 2012 (right). *Source: the author.*

Finally, the most outstanding feature of the HSR network is its radial character and the low availability of horizontal connections (see Figure 1.9.). The HSR network has meant a clear opportunity (connectivity improvement) to those cities with a station but not for intermediate territories (Plassard, 1991). Therefore, for the entire region, this transport mode has led to very low connectivity levels, being the access limited to only six municipalities (including the five CLM provincial capitals). The opportunities opened up by the HSR may be even more significant in the surroundings of ‘ex-metropolitan’ stations (established in suburban areas and cities of metropolitan regions, within 100 km distance from the metropolitan center) due to their capabilities to act as catalyst both for territorial (at the metropolitan scale) and for local transformations making them potential centers of economic growth. However, an in depth analysis of Madrilenian ex-metropolitan HSR stations (in contrast to those around London and Paris metropolitan centers) concluded that, conversely to what it could be expected, relocation of office activities has not taken place in the surroundings of CLM ‘ex-metropolitan’ stations (Toledo and Guadalajara) because their placement in the metropolitan area is discontinuous and they fail to connect to long-distance destinations (**MOHÍNO, I., LOUKAITOU-SIDERIS, A. and UREÑA, J.M. (2014)**, “Impacts of High-Speed Rail on Metropolitan Integration: An Examination of London, Madrid and Paris”, *International Planning Studies* 19 (3-4):306-334 - see Appendix II).

1 Both, the clustering coefficient and the betweenness centrality have increased from 0.25 to 0.48 and from 0.044 to 0.066, respectively.
6. GENERAL METHODOLOGICAL APPROACH

As previously mentioned, the debate regarding the evolution of metropolitan regions is closely related to transport developments (Baum-Snow, 2007; Helbich and Leitner, 2009). For the study area, SOLÍS, E., MOHÍNO, I. and UREÑA, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies 23(3):568-596 (see Appendix I) concluded the role of radial motorway corridors as growth vectors and identified that the urban structure of the Extended Madrid Metropolitan Area have re-concentrated over these high-capacity infrastructures. This study also showed that the development and generation of medium-sized cities takes place besides transportation corridors. Besides, those historic administrative cities located along corridors within 100 km distance from the metropolitan center favor the generation along them of clusters of elongated sub-systems of cities with a greater number of medium sized cities. All this justifies why the evolution of rural metro-adjacent regions’ transport network has been positioned at the heart of this dissertation. Thus, despite being aware that a complex set of economic and urban factors are causing or fostering these structural transformations, it is not the intention of this dissertation to go deep into their effects.

Appropriate interpretation and classification of an urban system require considering both city attributes (space of places) and functional linkages (spaces of flows) (Castells, 2000; Camagni, 2003; Taylor, 2007). In that sense, in understanding urban spatial structures, two main approaches are found in literature: morphological and relational. First, morphological approaches categorize nodes by their size, spatial location, and socioeconomic origin and evolution (Garreau, 1991; Giuliano and Small, 1993;
Champion, 2001; Ipenburg and Lambregts, 2001; ESPON, 2004; Parr, 2004; Muñiz et al., 2005; Burger and Meijers, 2012; Solís et al., 2012). These ones understand polycentric urban structures as a set of adjacent centers that are located within the same urban system. However, the mere existence of nearby sub-centers (with a certain size or centrality/economic profile) does not necessarily lead to insightful functional relations among them (Lambooy, 1998). Second, relational approaches describe relations (daily commuting, business and leisure travel, migration, etc.) among urban areas (Schwanen et al., 2001; Limtanakool et al., 2009; de Goei et al., 2010; Vanasen, 2012; Burger et al., 2013).

Nevertheless, certain systems can perform as morphologically but not functionally polycentric or vice versa. Therefore, some scholars suggest simultaneously incorporating in the analyses the two abovementioned approaches (Burger and Meijers, 2012; Hall and Pain, 2006; Hoyler et al., 2008; Solís, E., Mohíno, I. and Ureña, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies 23(3):568-596). Following that recommendation, to avoid misleading conclusions in characterizing rural metro-adjacent regions’ urban configurations, this thesis dissertation proposes a diachronic combined methodology based on morphological and functional dimensions (see Figure 1.10.). These analyses carried out for different time scenarios allow comparisons between the situation in 2011/2012 with that of 1981, prior to: a) the Spanish state rescaling process; b) Spain’s entry into the EU (in 1986); c) the noteworthy transformation of the traditional Madrid Metropolitan Area characterized by a population/economic decentralization; and d) the notorious improvement of transport systems (and the increased investments in regional transport networks under ‘national-regional’ rationales). Hence, this approach is proposed as a tool to examine the influence of metropolitanization and state rescaling processes in shaping urban systems of rural metro-adjacent regions (and their consequent functional linkages).

On the one hand, the morphological dimension is addressed by applying a diachronic multimodal accessibility analysis1 based on a combination of complementary indicators. It is important to mention that this dissertation does not intend to repeat the detailed morphological analyses already developed for the study area by Solís, E., Mohíno, I. and Ureña, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies 23(3):568-596 (see Appendix I), based on size, location and socioeconomic evolution, or by Pillet et al. (2010), based on demographic size and public facilities provision. These two works have been assumed as an accurate starting point and the analyses proposed in this dissertation complement them by paying attention to one of the two basic transport system components: the supply side. Accessibility2, understood as a spatial interaction facilitator (Hansen, 1959; Morris et al., 1979), is

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1 Accessibility analyses could also be considered as a relational approach since, to some extent, they include in the formulation their interactions with other places. Nevertheless, as they characterize the spatial structure of transport networks and not how they are used, they best suit within the morphological approaches.

2 One of the objectives when analyzing a transport network is to characterize its capability to connect different locations, that is to say, the cohesion of the territory brought about by the connectivity features of transport networks running through it. While connectivity analyses assist in understanding, describing and comparing different network attributes, they disregard demographic, political or socioeconomic factors. Therefore,
probably one of the most extensive empirical and theoretical concepts in transport analysis and has achieved an important level of complexity. Thus, given the capability of accessibility to embed spatial structures and their relationship with urban networks at several scales (van Wee et al., 2001; Geurs and van Wee, 2004; Horner, 2004), the proposed method is built for a better understanding of rural metro-adjacent regions’ spatial structure and the coherence of the transport infrastructures running through the regional territory. Particularly, the use of a combined/sequential approach acknowledges: a) the extension of catchment areas and the degree of interconnection; b) the potential for interaction and regional cohesion; and c) the specialization and city-profile of main centralities within the rural metro-adjacent region.

In order to calculate the study area accessibility changes, a dense multimodal network was modelled in a GIS geodatabase including both the road and HSR networks. The scale of analysis is set to the municipalities, placing each node at the centre of the built-up area and HSR stations at their exact location. Both for road and for HSR, accessibility is calculated considering all spatial relations (vectors) feasible with the existing infrastructure, which allows determining the opportunities provided by the network. Travel time was selected as the unit of analysis and was obtained: a) by computing the road network in GIS and b) by collecting the minimum in-vehicle HSR travel from RENFE’s (Spanish railway operator) website.

On the other hand, the functional dimension is addressed by applying a mobility analysis. Once the provision of transport infrastructures has been assessed, this second step pays attention to the real use rural population do of them, that is, the demand side. In polycentric urban configurations, the direction of functional linkages no longer meets/follows the traditional monocentric model and becomes increasingly complex (Cervero and Wu 1998; van der Laan et al. 1998; Burger et al. 2011). Thus, it is necessary to look at the direction of flows to describe functionally polycentric urban systems (characterized by the balanced distribution of functional linkages between the centers). Besides, apart from its already identified appropriateness for delineating sub-regional housing and labor markets (Burger et al., 2011; Hincks, 2012), analyzing the direction of functional relations is essential/useful to understand the interaction capabilities (in terms of emitting or attracting flows) of the urban system. A second issue about functional polycentrism is spatial integration which is assessed by addressing the strength of functional linkages between the centers. This allows delineating dependencies with the metropolitan center or other supra-regional territories (called within the limits of this thesis as ‘openness’) or with other areas within the same region (called as ‘territorial cohesion’).

_1_ Although the conventional rail was initially introduced in the model, preliminary results showed that it had no effect on accessibility patterns neither in 1981 nor in 2012, since none of the conventional rail connections were competitive with the road network ones; consequently, it was excluded from the model.

_2_ For potentially possible services using the existing infrastructure, in-vehicle time was estimated based on the commercial speeds of the existing services along the same line. Based on previous empirical analyses (Cambridge Systematics, Inc., 2006; Martín et al., 2014), 19 minutes have been added to each HSR connection in terms of ‘waiting time’. Access-egress time is directly obtained when running the GIS model since HSR stations are connected to the road network.
Figure 1.10. - Thesis methodological approach. Source: the author.
This functional approach is divided at the same time in two steps. The first one aims in characterizing changes in the articulation of recently rescaled rural metro-adjacent regions into metropolitan dynamics (and their openness to other territories) in contrast with their degree of self-containment and isolation (internal/regional cohesion). This is done by focusing on commuting travel purposes because: a) it has traditionally been the major daily recurrent form of travel (Nielsen et al., 2008; Hincks and Wong, 2010; Manaugh et al., 2010); b) it is one of the major forces of change in rural areas (ESPON, 2006) since, as an alternative to migration, it may give rise to the decrease of their depopulation (Sandow, 2008); and c) it is generally the most elaborate, reliable, and relevant interaction information available (Burger et al., 2014).

Moreover, since urban systems are multiplex phenomena and spatial interactions may vary regarding the type of functional relation/travel purpose and the workers’ socio-economic characteristics (Burger et al., 2014), a second step of the functional approach aims to compare the spatial organization of commuting and business travel patterns within rural metro-adjacent regions and to understand how education influences in shaping them (by looking at highly-skilled professionals in contrast to the average working population).

Nevertheless, rural areas generally lacks of mobility data, especially for less recurrent travel purposes. CLM is not an exception and one challenge faced by this research was, apart from the poor quality of official commuting CLM statistics, the lack of official CLM statistics for travel purposes other than commuting, particularly business trips. Thus, for these functional analyses, data were based on two original mobility surveys carried out during 2012. The first one, addressed to a sample of the regional households (see Chapter 3 - Section 3.4.1). The questionnaire (see Figure 1.11.) was organized in two sections: a) questions about the household and its head (place of residence, gender, age, number of children in the household, education level, occupation); b) questions about travel to other municipalities: work-related travel (commuting and business trips undertaken during the previous complete working week) and non-work-related travel (going shopping, hiring consultancy services, visiting health facilities, leisure) undertaken during the previous complete working week. The second survey was addressed to three professional sectors (Architects, Civil Engineers and Lawyers residing in CLM) in an attempt to identify differences between those with university education (see Chapter 3 - Section 3.4.1). This questionnaire (see Figure 1.12.) included questions about: a) the surveyed professionals (gender, age, municipality of residence) and the company they worked for (freelance or contractual basis, public and/or private sector, size in terms of the number of offices, location of the headquarters); b) the regular workplace municipality and the transportation mode used to access it; and c) the business travel destinations during the previous complete working week.

1 The 2011 Spanish Census has important constraints: a) it only provides information about a sample from each municipality; b) the total number of out-commuting flows is not provided for the smallest municipalities (accounting for approximately two-thirds of the CLM municipalities) and there is no clear threshold above which data is publicly available; and c) commuting information is only published for workplace municipal type of location (distinguishing among the same municipality of residence, different municipality within the same province of residence, different province within the same region, other region, other country) and size (and not by specific flow destinations).
Figure 1.11. - Regional households mobility survey. Questionnaire. Source: the author.
Figure 1.12. - Regional highly-skilled professionals mobility survey. Questionnaire. Source: the author.
Figure 1.12. (Cont.) - Regional highly-skilled professionals mobility survey. Questionnaire. Source: the author.
7. THESIS CONTRIBUTIONS

To sum up, in a context of global economic and socio-cultural changes and monocentric metropolitan areas becoming polycentric and overflowing their influence beyond their traditional boundaries, the first main contribution of this thesis dissertation to the literature on contemporary spatial configurations is in terms of the scale of analysis, by overcoming the lack of understanding around rural metro-adjacent regions.

Apart from that, a second main contribution of this dissertation is the proposal of a combined morphological and relational methodology (based on accessibility and mobility analyses) to characterize the urban spatial configuration of Extended Multinodal Urban Regions at the supra-regional scale, with a special attention on their rural metro-adjacent regions. This methodology enables the assessment of the impacts metropolitan influence and state rescaling play on urban configurations and functional coherence of recently reconfigured rural metro-adjacent regions. Besides, each of the two steps in which the proposed methodology is divided significantly complements the existing literature:

- On the one hand, whilst several previous studies have traditionally focused on the impacts of highways and more recently of high-speed rail, most of them fail in isolating the impacts of the various transport networks (which may have resulted in contradictory conclusions). Thus, the diachronic sequential and multimodal accessibility approach contributes to the understanding of rural metro-adjacent regions’ spatial transformations in regards to three key urban processes: extension, interaction and competition among centers, and to the evaluation of infrastructure investments coherence/feasibility in promoting (internal) cohesion and competitiveness. The relevance of simultaneously assessing the impacts of road and HSR networks lies in the fact that since the last ones are only accessible in very few points (HSR stations), it is necessary the existence of an alternative transport (road) network to allow access to each station.

- On the other hand, as a complement to the vast number of explorations on migration patterns, the mobility approach contributes to the characterization of evolving rural metro-adjacent regions’ functional linkages (in relation with the underlying city network) by comparing different travel purposes (commuting versus business) and different socio-economic profiles (average working population versus highly-skilled professional).
PART II – EMPIRICAL CONTRIBUTIONS
Chapter 2

Understanding Accessibility Patterns

1. INTRODUCTION

Accessibility occupies a central place in several scientific fields such as Transportation or Urban Planning and Geography, since it is considered crucial to promote regional economic development\(^1\). Therefore, most governments include improvements in accessibility as one of the primary objectives of their transport policy. However, beyond this economic perspective, the concept of accessibility has been proposed as a sophisticated tool to visualize and to analyze spatial processes (Harris, 2001; Patuelli et al., 2007; Reggiani et al., 2011; Cheng et al., 2013).

Equal access opportunities to markets not only constitute a key factor in achieving harmonious economic developments but in reducing regional disparities/imbalances and in promoting territorial cohesion, which is one of the EU’s main objectives (EC, 1999 and 2004). In succeeding these objectives, EU policies emphasize the relevance of polycentric developments to avoid disparities between central EU areas (the Pentagon) or metropolitan areas of each member state and many rural regions. Besides, transport networks represent a key element for achieving territorial cohesion within the EU and a substantial proportion of the structural funds have been assigned for transport improvements. Spain is a good example of that: i.e. between 1994 and 1999, transport infrastructure absorbed 40% of the structural funds, financing the construction of almost 2,400 km of motorway and 3,400 km of roads in ‘Objective 1’ regions (Condeço-Melhorado, 2011).

Different definitions have been proposed for the concept of accessibility. The definition adopted in this dissertation relates with the one suggested by Dalvi and Martin (1976): the ease with which any land-use activity within a given location can be reached using a particular transport system. In that sense, accessibility represents the interrelation between the role of transport networks and land-use patterns, providing relevant information regarding urban spatial structures (Kawabata, 2009). As

\(^1\) Improvements in accessibility give rise to changes in the value of a region’s economic potential (Keeble et al., 1988; Vickerman, 1996; Vickerman et al., 1999; Condeço-Melhorado, 2011)
showed along this chapter, different formulations have also been proposed to measure accessibility depending on the aims of each study.

The remainder of this second chapter gathers the paper MOHÍNO, I., UREÑA, J.M. & SOLÍS, E. (Mimeo), “Transport Infrastructure and Territorial Cohesion in Rural Metro-adjacent Regions: A Multimodal Accessibility Approach. The Case of Castilla-La Mancha in the Context of Madrid (Spain)”, submitted to Transport Policy (Under review). This paper describes in detail the first step of the proposed methodology to characterize rural metro-adjacent regions’ urban reconfigurations (see Figure 1.10.). By addressing a multimodal accessibility analysis (morphological approach), the internal territorial interconnection and cohesion of the CLM rural metro-adjacent region (and their changes over time) are analyzed in contrast to its outstanding traditional integration into Madrid metropolitan dynamics. Apart from explaining urban structure changes within rural metro-adjacent regions, this sequential analysis based on accessibility indicators concludes with a proposed typology of different city-profiles in terms of the competitive advantages acquired over time as a result of transport investments.

This approach is based on a previous one carried out by the PhD candidate. That previous methodology was tested for territories within rural metro-adjacent regions located close to the metropolitan center and, consequently, more integrated in metropolitan dynamics. The results of this already published first test are presented in Paper A.3 (see Appendix III): MARTÍNEZ, H., MOHÍNO, I., UREÑA, J.M. and SOLÍS, E. (2014), “Road accessibility and articulation of metropolitan spatial structures: the case of Madrid (Spain)”, Journal of Transport Geography 37: 61-73. Nonetheless, some deficiencies were identified and a set of improvements were proposed/included to polish that methodology: a) the simultaneous/combined evaluation of different transport modes by incorporating the HSR network; b) a more in depth analysis of the activities that are possibly carried out at destinations for certain travel time budgets is carried out; c) the refinement of both the distance decay function based on a recent Spanish case study calibration and the self-potential estimation; d) a redefinition of the city-profiles typology capabilities for competing for workplaces and for potential workers.

The potential of this sequential methodology and the analysis of their results in a complementary manner is twofold. First, it avoids misleading conclusions that may appear when computing a single accessibility indicator. Second, it (each indicator) allows capturing/acknowledging different components of rural metro-adjacent regions spatial structure: a) interconnection and extension, b) interaction and cohesion and c) specialization and city profiles. Besides, by considering a multimodal approach, the real effects/impacts of the complementary road and rail networks.

In summary, this paper contributes in analyzing changes in the spatial distribution of accessibility in order to evaluate the impacts of investments on high-capacity infrastructures in less competitive/rural regions with metropolitan influence. This would provide the planning process with useful information on whether transport network improvements help increasing intra-regional connections
(leading to more polycentric urban networks) and reducing regional disparities (in terms of accessibility).

Nevertheless, this methodology is, to some extent, an assessment of ‘potential’ accessibility, that is, the facility with which activities may be reached by considering all roads segments and all HSR station-to-station combinations, independently of the actual existence of transportation services (as it is commonly done by most accessibility studies). While for the road network it is appropriate not to consider access constraints apart from the existence of an infrastructure, the accessibility by HSR is determined by the service supply: HSR services are the ones truly facilitating the use of this transportation mode. A first approach to this issue (still in a very preliminary stage) was presented at the Conference “High speed rail and the city: tourism and dynamics around stations” held by the University of Paris-Est Marne-La-Vallée in January, 2015. This conference contribution has resulted in the elaboration of Paper A.4 (see Appendix IV): MOHINO, I., DELAPLACE, M. and UREÑA, J.M. (Mimeo), “High-Speed Rail Networks and Station Surroundings Valorisation Policies: The case of Cities about 1 hour from Metropolises”, Submitted to Belgeo (accepted with major revisions). This first approach analyses the interactions within metropolitan HSR networks, in regards to their topology and the type of services at each station (distinguishing between radial connections to/from the metropolis and tangential ones between distant territories).

Nevertheless, since this is only a first approximation to the HSR service provision issue, future studies should follow that line of research to measure more accurately the extent to which a place is able to reach an activity by means of the provided HSR services in contrast to the potential of that place for interaction based on all possible pair of connections. This assessment of the ‘real’ accessibility in contrast to the ‘potential’ one is relevant in terms of policy to best take advantage of the already built infrastructure: such as increasing the frequency of services or reducing the ticket prices.
2. INTEGRATION, INTERACTION AND COMPETITION CAPABILITIES IN RECONFIGURED RURAL METRO-ADJACENT REGIONS

This section presents the paper:


Abstract. This paper aims to understand first, the internal territorial interconnection and cohesion of rural metro-adjacent regions in contrast to their outstanding integration into metropolitan dynamics; second, their polycentric urban structure; and third, the influence of their multimodal transport system on the two previous issues. The main contribution of this work is the proposal of a diachronic combined/sequential and multimodal accessibility approach to explain the urban structure changes within rural metro-adjacent regions and to identify different city-profiles in terms of the competitive advantages acquired over time as a result of transport investments. The research focuses on Castilla-La Mancha, a Spanish rural region under the influence of Madrid Metropolitan Region, by comparing the present situation with that previous to the Spanish state re-scaling and by considering two transport investments rationales: the traditional national one and the recent 'national-regional' one. The findings reveal: a) the enlargement of catchment areas, towards Madrid and within Castilla-La Mancha, and the region becoming more internally interconnected and polycentric for high travel time budgets; b) a greater regional cohesion, although the highest levels of potential for interaction are still concentrated in a few cities; and c) the main centres of the urban structure performing different employment or residential roles due to competition among them.

Keywords. Accessibility, Regional cohesion, Metropolitan integration, Rural Metro-adjacent Regions, Polycentric Urban Regions, Spain.

2.1. INTRODUCTION

The impact of transport infrastructures on economic growth and urban spatial configurations has been one of the key subjects of debate (Biehl, 1991; Gordon and Richardson, 1996; Vickerman et al., 1999; Baum-Snow, 2007), with special attention recently paid to cohesion and sustainability issues (EC, 1999 and 2004; ESPON-INTERACT, 2006b). Improved transport networks result, on the one hand, in a time-space convergence, expanding potential catchment areas (Spiekermann and Wegener, 1994), and on the other hand, in the emergence of polynuclear urban structures and complex functional relations (Clark and Kuijpers-Linde, 1994; van der Laan, 1998; Kloosterman and Musterd, 2001; Cheng et al.,
supported by advances in telecommunications and by economic activities decentralisation and residential dispersion.

The concept of accessibility has become central in regional and transport planning studies (Hillman and Pool, 1997; Geurs and van Wee, 2004; Gutiérrez, et al., 2010; Rosik et al., 2015), its spatial distribution being a good proxy to assess territorial imbalances (Schürmann et al., 1997; Halden, 2002; Bröker et al., 2004; EC, 2004; Reggiani et al., 2010). However, since results may vary in regards to the scale of analysis and the accessibility measure/approach applied (Bruinsma and Rietveld, 1998; Talen, 1998), some scholars have suggested “computing a set of accessibility indicators and analysing their results in a complementary way” (López et al., 2008:278) in order to avoid inaccurate conclusions.

Despite the fact that several studies have traditionally focused on the impacts of highways (Rietveld and Nijkamp, 1993; Chandra and Thompson, 2000; García-López, 2012) and more recently of High-speed Rail (thereafter HSR) (van den Berg and Pol, 1998; Rietveld et al., 2001; Preston and Wall, 2008; Monzón et al., 2013), most of them fail in understanding these effects at the disaggregated level (separating the impacts of the various modes of transport). Thus, due to possible contradictory results when isolating the analyses of specific transportation modes (López et al., 2008; Kotavaara et al., 2011), a multimodal approach is necessary to depict the real effects/impacts of transport networks. The relevance of simultaneously assessing the impacts of road and HSR networks lies in the fact that since the last ones are only accessible in very few points (HSR stations), ‘islands’ with enhanced levels of accessibility appear around them. The size of these islands varies in regards to the quality of the transport (road) network that allow access to each station (Monzón et al., 2013). Besides, a multimodal analysis considering the HSR network is also required because secondary cities which fail to connect to the HSR network (‘tunnel effect’ – Plassard, 1991) may be negatively affected by economic activities relocating at HSR cities (Pol, 2003).

Moreover, whilst much has been written in regards to the impacts of new high-capacity transport networks, in depth analyses are needed to understand these changes within rural\(^1\) or sparsely populated areas (Garmendia et al., 2012; Martínez & Givoni, 2012), which have recently received a special consideration in European policies\(^4\). The future of these rural areas depends, among other

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1. In an analysis of the large-scale road and rail transport infrastructure investments carried out in Spain in the period 1992-2004, López et al. (2008) conclude that cohesion has improved for the road mode, while regional disparities have increased for the rail mode.
2. “For example, accessibility of the highway network has been found to have a contributing effect on population increase (Chi, 2010), whereas accessibility by railways has been observed to have a positive effect on urban populations, though an opposite effect on rural population in some cases (Vaturi et al., 2011)” (Kotavaara et al., 2011:926), widening regional inequalities and polarizing spatial distribution of accessibility levels (Gutiérrez et al., 1996; Puga, 2008; Ortega et al., 2012), reinforcing the privileged situation of the main network nodes (improvements in accessibility concentrate near HSR stations), to the detriment of intermediate locations (Vickerman et al., 1999; Puga, 2002; Martínez & Givoni, 2012).
3. There is no single internationally accepted definition for ‘rural’ areas. In 2009, the OECD Working Party on Territorial Indicators (WPTI) approved and adopted the following regional typology (OECD, 2011): Predominantly Urban (PU), Intermediate Close to a city (INC), Intermediate Remote (INR), Predominantly Rural Close to a city (PRC) and Predominantly Rural Remote (PRR). According to this, rural regions (the last two types) are those ones characterized by a share of population living in rural local units (administrative entities with a population density below 150 inhabs/km\(^2\)) higher than 50%. A distinction is made regarding the percentage of the regional population that is within 60 min driving time from the closest location with more than 50,000 inhabs.
4. In the European context, rural areas are particularly important in terms of territory: in 2007 in the EU-27, rural areas represented 91% of the territory and 59% of the population.
factors, on their physical infrastructure, allowing them to evolve energetically. Consequently, it is essential to understand the current situation of these rural regions and whether they are performing better and/or more autonomously after being increasingly taken into consideration in European territorial strategies. However, the challenge facing rural areas varies according to their location in relation to major cities, distinguishing among: a) those close to them and also those relatively further away but with very good transport links, and b) those isolated and sparsely populated rural areas, situated in peripheral locations and far from urban centres and main transport networks (EC, 2004:30).

Motivated by the increasing importance of urban-rural linkages as mechanisms supporting diffusion of growth, this paper focuses on the first group which are close to metropolises and thus, have a predominant passing-through character and in many cases are supplied with a few HSR stations.

Bearing in mind the two abovementioned gaps in literature, the contribution of this paper is a diachronic combined/sequential and multimodal accessibility approach as a tool to understand urban structure transformations within rural and sparsely populated regions highly influenced by metropolitan processes, what we call ‘rural metro-adjacent regions’, trying to capture three key urban processes: extension, interaction and competition among centres, and to evaluate the coherence/feasibility of their infrastructure investments in promoting (internal) competitiveness. The research is set under three hypotheses: first, that improved transport systems under ‘national-regional’ investments rationales within these rural territories result in a scale shift of reachable areas, allowing greater internal interconnection levels (in contrast to the traditionally predominant functional linkages towards metropolitan areas) and strengthening the emergence of a more polycentric urban structure; second, that transport infrastructures are a facilitator for territorial cohesion within rural metro-adjacent regions (diminishing regional disparities); and third, that different city-profiles could be found among the regional urban centres due to differences in the infrastructure provision (for instance, having, or not, direct access to the HSR network) and their consequent competition effects.

Particularly, accessibility impacts are assessed for Castilla-La Mancha (hereinafter CLM), a Spanish rural region under the influence of Madrid, by comparing the present situation with that of 1981, previous to the Spanish state re-scaling process, the proliferation of motorways and the construction of the HSR network. These two temporal scenarios also allow capturing two different transport investments rationales: the national, which traditionally aimed in connecting the main areas within the national territory, and the ‘national-regional’, which has acquired a key role since the Spanish state rescaling and seeks articulating also medium-sized cities and fostering intra-regional linkages.

1 Particularly, European ‘Objective 1’ regions (with a GDP per head less than 75% of the EU average), in PPS terms, experienced a higher rate of growth than other parts of the Union between 1988, when the Structural Funds were reformed, and 2001 (EC, 2004:6).

2 Intermediate HSR stations have progressively been created at lower distances than the ones for which HSR connections were planned (400-600km): a) in small and medium-sized cities in suburban areas/cities of metropolitan regions, within 100 km distance from the metropolitan centre (Garmendia et al., 2012) and b) in small and medium-sized cities within 1 hour distance by HSR (approximately 200 km) from the metropolitan centre (Garmendia et al., 2011a and b).

3 The spatial concept of cohesion is used as a synonym of ‘more balanced development’, ‘territorial balance’ and ‘for avoiding territorial imbalances’.
The remainder of this paper is organized as follows: Section 2.2 builds on the theoretical approach, connecting the issues of transport investments, polycentric developments and cohesion, and presenting the opportunities of spatial accessibility analyses in capturing urban systems transformations; Section 2.3 characterises the case study and describes the proposed accessibility model; Section 2.4 gathers the main results and outcomes; Section 2.5 summarises and discusses the research conclusions.

2.2. BACKGROUND

2.2.1. Transport infrastructures, polycentric urban systems and cohesion

One of the European Union’s objectives is to promote economic, social and territorial cohesion in order to reduce disparities between regions, preventing territorial imbalances with a special concern on rural regions (EC, 1999 and 2004). To achieve that, the European Spatial Development Perspective proposes the development of a multi-centred and balanced urban system, in parallel with the reinforcement of rural-urban collaborations (beyond the traditional city–countryside dualism), promoting integrated transport and communication, and securing parity of access to infrastructure and knowledge (EC, 1999) (see Figure 2.1.). This has resulted in the European, national, and regional investments encouraging polycentric urban networks, particularly in structurally weak regions (‘Objective 1’ and ‘6’) (EC, 1999), in which medium-sized cities (acting as network nodes) would play a key role (Hildreth, 2007; ESPON, 2006a and 2012; Cox, 2012; Solís et al., 2015).

This idea of polycentrism focuses on three main scales (Escudero and Somoza, 2010): a) European Union level (promoting dispersed development of dynamic growth centres others than those concentrated in central regions); b) regional level (developing a set of interconnected urban centres rather than a dominant one); and c) intra-city level (a city or a multi-centred urban area comprising a main core and a set of sub-centres). Current land-use strategies concentrate mainly on the second level, strengthening Polycentric Urban Regions (Davoudi, 2004), defined as regions with three or more historically and politically separated cities which are not hierarchically ranked, are located in reasonable proximity to each other, and have significant functional interconnections and complementarity. Although in these urban structures externalities are shared among close and interconnected intermediary urban centres, each one acquires a distinct city-profile (see Figure 2.1.) in regards to its size, function/specialization, socioeconomic evolution, etc.

1 “The creation of networks of smaller towns in less densely settled and economically weaker regions is also important. In these areas, co-operation between urban centres to develop functional complementarity may be the only possibility for achieving viable markets and maintaining economic institutions and services which could not be achieved by the towns on their own” (EC, 1999:21).

2 “Polycentricity is not a goal in itself but one of the means to achieve policy objectives such as economic competitiveness, social equity and sustainable development” (ESPON, 2004:7).

3 Many Spanish Autonomous Communities are proposing such a regional polycentricism as part of their land-use strategies.
Transport improvements have also been considered crucial for reducing regional disparities (EC, 2004), with a special consideration on the opportunities opened up by HSR (EC, 1999). For this reason, funds have been devoted to transport infrastructure investments, especially to those projects with low profitability in terms of cost-benefit ratios (López et al., 2008). This is the case of the so-called European structural funds to promote cohesion within ‘Objective 1’ (least developed) European regions (since accessibility gains may bring significant progress in economic development for these regions). The spatial distribution of accessibility has been widely used to assess regional disparities (see section 2.2.2), since different accessibility levels would increase territorial imbalances (EC, 2004).

Nevertheless, transport investments and increased cohesion do not follow a causal relationship (López et al., 2008) and some scholars argued that improved connections between strong and competitive centres and economically weak peripheries may result in a less balanced development (Vickerman, 1995; Peters, 2003). In that sense, this paper contributes in analysing changes in the spatial distribution of accessibility in order to evaluate the impacts of investments on high-capacity infrastructures in less competitive/rural regions with metropolitan influence. This would provide the
planning process with useful information on whether transport network improvements help increasing intra-regional connections (leading to more polycentric urban networks) and reducing regional disparities (in terms of accessibility).

2.2.2. The assessment of accessibility as a tool for evaluating territorial cohesion

As previously mentioned, accessibility has been commonly used in transport and urban planning. On the one hand, as a tool to evaluate economic, land-use and social impacts of new/projected infrastructures (Gutiérrez et al., 1996; Geurs and van Wee, 2004). On the other, to understand the spatial organisation of urban systems (Harris, 2001) since it is an important factor for competitiveness of places (Biehl, 1991; Rietveld and Nijkamp, 1993).

A considerable number of definitions have been proposed for the concept of accessibility, although all of them sharing the same idea: the capability/ease of places for being reached from other areas by using a certain transport system. Two types of formulations have been used to measure it: a) infrastructure and location based ones, both of them focused on the transport system and land-uses characteristics, and b) person and utility based ones, which incorporate ‘non-physical’ components representing demand, such as the socioeconomic status or the workforce profile.

Thus, one of the challenges related to effectively measuring accessibility is associated with the type of approach that best addresses the problem. However, location-based formulations have typically been used in urban planning and geographical studies (Geurs and van Wee, 2004) and different measures have been used to assess it, such as the contour or potential ones.

The contour measure (Ingram, 1971; Vickerman, 1974; Bertolini et al. 2005) assesses the number of opportunities which can be reached within a fixed travel time budget (hereinafter TTB), distance or cost, defining the ‘catchment areas’ in terms of proximity.

One of its main limitations is that results greatly vary depending on the considered threshold, its selection being key as showed by the extensive range of TTB gathered in the literature (Kawabata, 2009; Curtis and Scheurer, 2010; Reggiani et al., 2011). The issue of a constant TTB has been widely explored

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1 Improved accessibility usually contributes to the concentration of economic activities (Rietveld and Nijkamp, 1993)
2 Accessibility has been defined as ‘the potential of opportunities for interaction’ (Hansen, 1959); ‘the ease with which any land-use activity can be reached from a location using a particular transport system’ (Dalvi and Martin, 1976); ‘the facility with which activities may be reached from a given location by using a certain transport system’ (Morris et al., 1979); ‘the freedom of individuals to decide whether or not to participate in different activities’ (Burns, 1979); ‘the benefits provided by a transportation/land-use system’ (Ben-Akiva and Lerman, 1979); or ‘the extent to which land-use and transport systems enable (groups of) individuals to reach activities or destinations by means of a (combination of) transport mode(s)’ (Geurs and van Wee, 2004).
3 For a complete explanation of each one see Geurs and van Wee (2004).
4 They are also known as isochronic, cumulative opportunities, proximity count or daily accessibility measures.
5 These concluded different travel time expenditures may be influenced by the research itself: the survey period, the objectives of the study, the methodologies employed and the unit/s of analysis (i.e. all individuals versus travellers only) or the modes and travel purposes included.
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(Zahavi and Ryan, 1980; Goodwin, 1981; Hubert and Toint, 2006; Susilo and Kitamura, 2008) and recently, except at the most aggregate level, evidence against it has been found (van Wee et al., 2002; Levinson and Wu, 2005): they are strongly related to the population size, the residential area’s urban form, the socioeconomic characteristics of individuals/households or the travel purpose and the type of activities at destinations (Landrock, 1981; Mokhtarian and Chen, 2004).

Nevertheless, most of the existing studies look at the average daily travel time and only few of them disaggregate it for different travel purposes1 (Morris et al., 1979; Landrock, 1981; Levinson and Wu, 2005; Raux et al., 2011). For instance, a recent ESPON2 report set in 45 min the threshold up to which commuting flows predominantly occur (ESPON, 2004). Apart from this one, Martínez et al. (2014) also considered that most accesses to services take place up to 30 min TTB. In regards to business trips, different studies have concluded that they take place over longer distances than commuting and that individuals are willing to spend more time for this purpose (Aguilera et al., 2009; Mohino et al., 2014). HSR has had a noteworthy impact on travel times3, allowing commuting up to one hour train travel time (not including access/egress and waiting times) when linking with metropolitan destinations and with adequate/feasible timetables/fares, and day return business travel between 1.5 and 3 hours (Ureña et al., 2005 and 2009).

In order to account for a distance decay function to weight the opportunities (a shortcoming of the contour indicator), potential measures4 evaluate the facilities to which a region has access once the cost/time of covering the distance has been considered (Harris, 1954; Sohn, 2005; Condeço-Melhorado et al., 2011; Reggiani et al. 2011). Different functions have been proposed to account for this friction: power, Gaussian, logistic or negative exponential (Geurs and van Wee, 2004).

A self-potential or internal accessibility issue, that is, the contribution of the opportunities (population, jobs, etc.) of a zone to its own potential, arises in these measures since it can represent an important part of the total potential market of a certain node (Bruinsma and Rietveld, 1993), particularly in highly populated or large regions where most relations are established internally. However, each zone’s mean internal distance or travel time is not easy to approximate and only a few estimations have been proposed: on the one hand, in regards to the city population, by establishing an hypothesized intrazonal time/distance within small urban areas and by including congestion in bigger ones.

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1 The mean daily travel time per person in the city of Ballarat in the 1970s varied from approximately 1 minute for employer’s business, eat, medical or personal business to 4 minutes for shopping or 9 min for social/recreational destination purposes and to 11 min for work (Morris et al., 1979). For the eight European cities compared in Raux et al. (2011), this figures varied from 28-35 min for work travel purposes to 18-24 min for shopping/personal business and to 21-34 min for social recreation purposes. The average travel time (of trips done by car) for the Washington metropolitan region in 1994 varied from 30-49 min for commuting and from 17-19 min for other travel purposes (Levinson and Wu, 2005). During the 1990s, in Great Britain, average daily journey time varied form 12 min for commuting, 8 min for shopping and 13 min for social (including eating and drinking) travel purposes, being these figures greater for London residents and lower for smaller municipalities (Landrock, 1979). In 2006, a Spanish mobility survey (MOVILIA) concluded that average travel time varied form 24 min for commuting, to 15 min for shopping and to 17 min for leisure travel purposes, being these figures greater for municipalities within metropolitan areas and increasing with population size.

2 European Spatial Planning Observation Network.

3 In terms of accessibility, HSR is not competitive in comparison with private car for short TTB commutes, since a ‘waiting-time’ has to be added to the in-vehicle time.

4 Also called gravity-based measures
(Gutiérrez, 2001; Condeço-Melhorado et al., 2011) or on the other, as a function of each centre’s built-up area (Spence and Frost, 1995; Gutiérrez et al., 2011; Kotavaara et al., 2011).

Whilst the potential measure overcomes some of the contour indicator’s shortcomings by evaluating the combined effect of land-use and transport components and incorporating individuals’ perceptions of transport (with a distance decay function), they exclude competition effects. Not accounting for competition may lead to inaccurate or even misleading results (Geurs and Ritsema van Eck, 2001; Geurs and van Wee, 2004), although regional distributions do not radically change. Some authors have adapted the potential functions to produce competition measures. Some analyse accessibility where competition only takes place in destinations (Joseph and Bantock, 1982). Others ground competition in origins (Weibull, 1976). A third group considers competition at both origins and destinations based on the balancing factors of Wilson’s double constrained spatial interaction model (Wilson, 1967; Horner, 2004; Patuelli et al., 2007) and are “better suited for analysing spatial balancing or matching between residential and employment locations” (Cheng et al., 2013). Nevertheless, two are the main disadvantages of these competition measures: their calculation (that requires iterative estimation procedures) and their interpretability and communicability (due to its complexity for assessing from an iterative process).

From a different perspective, person-based measures (which analyse accessibility from the viewpoint of individuals incorporating spatial and temporal constraints) have great theoretical advantages in contrast to the abovementioned location-based ones. However, a remaining shortcoming is that they do not account for competition effects. Moreover, due to complexity and data requirements for person (and utility) based measures, their application to relatively small regions and subsets of the population are not appropriate.

2.3. EMPIRICAL MODEL AND STUDY AREA: ASSESSING MULTIMODAL ACCESSIBILITY PATTERNS FOR THE CASTILLA LA MANCHA RURAL REGION IN THE CONTEXT OF THE MADRID METROPOLITAN AREA

Given the capabilities of accessibility to explain the spatial structure of urban systems, a diachronic, combined and multimodal accessibility approach is proposed in this paper to understand the dynamism of rural metro-adjacent regions from a morphological perspective, by looking at the possible interactions between centres and not just by assessing their size distribution (or the absolute importance of cities).

1 Applied to The Netherlands, a comparative accessibility analysis between various formulations demonstrated revealing conclusions: if the interdependent competition for jobs and among the labour force is incorporated, job accessibility (at the national level) is lower. Job accessibility in central and suburban areas is relatively sharply reduced as a result of a relative large labour force within reach (more competition) whereas peripheral areas show a relatively strong increase as a result of a relative small labour force within reach. (Geurs and Ritsema van Eck, 2001).

2 “The measures are demand-oriented and do not include potential capacity constraints of supplied opportunities (e.g. job vacancies)” (Geurs and van Wee, 2004:135).
This accessibility model is applied to the two adjacent Spanish administrative regions of Madrid and Castilla-La Mancha (see Figure 2.2.) over the last three decades.

2.3.1. The Castilla-La Mancha Rural Region in the context of the Madrid Metropolitan Area.

During the 1980-2012 period, two processes took place in Spain: a state rescaling which led to an urban spatial reconfiguration (with the creation of the Administrative Regions\(^1\)) and a noteworthy transport system change, not only around the main urban centres (by the densification of the road network) but also within the least favoured regions (by the extension of the motorway network and the proliferation of HSR) favoured by a transition in the investment rationale, from a national perspective (which traditionally aimed to connect the main urban centres, conditioning the ‘passing-through’ character of transport infrastructures within inland regions) towards a ‘national-regional’ one (which gives more relevance to the articulation of medium-sized cities, fostering intra-regional linkages).

This research focuses on CLM, an ‘Objective 1’ rural region with the lowest demographic density in Spain (26.7 hab/km\(^2\) in 2012), located approximately between 40 km to 300 km from the Madrilenian metropolitan centre, and traditionally characterized by a weak internal functional cohesion and a conspicuous relation with outside adjacent urban areas. These interactions are especially strong with the Madrid Region (Feria and Albertos, 2010; Solís \textit{et al.}, 2012; Sanz and Vizcaíno, 2014), mainly with the metropolitan centre but also with its influence area which comprises 31 medium-sized intermediary cities\(^2\) (hereinafter MIC) (see Figure 2.2. and Solís \textit{et al.}, 2015). Divided into five provinces (with Toledo as the new regional capital), CLM is predominantly composed of municipalities under 2,000 inhabitants (78.8\% in 2012) although only a low percentage of the total regional population resides at them (14.8\% in 2012). Recently, some studies accounted for an incipient CLM polycentric urban structure (Pillet \textit{et al.}, 2014) organized by 11 centres of Functional Urban Areas\(^3\) (FUAs), each one with more than 15,000 inhab., and which constitute the main CLM urban structure concentrating the 35.0\% of the regional population.

Taking into account not only population but also employment\(^4\), a set of 40 leading poles (see Figure 2.2.) have been identified as those centres with a conspicuous potential in organising the area, greater interaction capabilities (potential accessibility) than the regional averages and an outstanding

\(^1\) Spanish Administrative Regions are equivalent to the NUTS-2 territorial subdivisions in the European Nomenclature.

\(^2\) A medium-sized intermediary city (MIC) is defined as a nuclei of between 20,000 and 250,000 inhabitants (Solís \textit{et al.}, 2015).

\(^3\) Functional Urban Areas (FUAs), are key drivers of European, national, regional and local economic performance and important territorial structures in delivering on the Europe 2020 targets, because of their role in sustaining a critical mass for development, strengthening urban-rural linkages and encouraging cooperation between cities. Europe is characterised by a polycentric network of FUAs, reflecting the diversity and density of the European urban system.

\(^4\) As some scholars suggest, not only the size of the centre but also its function, accessibility and capabilities to organize functional linkages of the surroundings should be taken into account (Pillet \textit{et al.}, 2007). For this reason, an employment supply threshold has been included to identify main regional centralities.
competition for opportunities with each other. According to the ‘employment centres’\(^1\) previously identified by Romero et al. (2014) within the Madrid region, 18 of the 31 MIC are considered ‘Madrilenian Leading Poles’. Within CLM, leading poles are defined in this paper as those cities with more than 15,000 inhab. and 2,500 jobs in 2012, concluding a set of 21 ‘CLM Leading Poles’ (all FUA centres are included among them).

Both sets of centres, the first one considering only population and the second one including also employment, are used at two different steps of the methodology (see Table 2.1.).

This regional urban structure has been historically influenced by its passing-through transport system. However, to the improved traditional radial motorway network connecting with Madrid, a few tangential motorways have been recently built within CLM (CM-42, A-43 and A-40) and others are still under consideration with the aim of facilitating intra-regional relations. Besides, four radial national HSR lines were built between Madrid and the Spanish coastal metropolises, three of them calling at the CLM capital cities (and one also at the secondary/non-capital city of Puertollano) and with some possible tangential connections between CLM territories along two by-passes in the surroundings of Madrid.

While most previous scholars studying accessibility changes at the Spanish central area focus on the Madrid Urban Region road network (Gutiérrez and Gómez, 1999; Gallo et al., 2010; García, 2010; Martínez et al., 2014), not considering more distant areas (which nevertheless are importantly influenced by metropolitan processes). The extension of the analyses to the CLM region are recently acquiring more relevance (Pillet et al., 2007 and 2014), being extremely interesting those ones combining the two regions in an attempt to depict interactions between them (or within each of them) (Solís et al., 2012, 2015; Mohino et al., 2014c).

\(^1\) These Madrilenian employment centres (MEC) are cities with more than 40,000 inhabitants in 2010 and more than 20,000 employees in 2007 (Romero et al., 2014).
Figure 2.2. - Study Area: the Madrid and Castilla-La Mancha regions. (Above) Transport network evolution (1981 and 2012). (Below) Madrid and CLM leading poles (2012). Source: authors.
### 2.3.2. A diachronic, combined and multimodal accessibility analysis

In order to calculate the study area accessibility changes, a dense multimodal network was modelled in a GIS geodatabase including both the road and high-speed rail networks. Although the conventional rail was initially introduced in the model, preliminary results showed that it had no effect on accessibility patterns neither in 1981 nor in 2012, since none of the conventional rail connections were competitive with the road network ones; consequently, it was excluded from the model. The scale of analysis is set to the municipalities, placing each node at the centre of the built-up area and HSR stations at their exact location. Both for road and for HSR, accessibility is calculated considering all spatial relations (vectors) feasible with the existing infrastructure, which allows determining the opportunities provided by the network.

Travel time was selected as the unit of analysis and was obtained as follows:

- **a)** by computing the road network in GIS. In doing so, five road types were identified (motorway, conventional road – distinguishing national, regional and local conventional roads- and urban artery/city street), assigning to each one a maximum speed according to the existing standards at each time scenario: 1981 (100, 90, 70, 50, 30 km/h, respectively) and 2013 (adding 10 km/h more). Congestion is included in the model, first, by reducing 80% the speed at road crossings, and second, by estimating some metropolitan roads speed based on assessed congestion levels (Abadía and Pineda, 2009).

- **b)** the minimum in-vehicle HSR travel time is obtained from RENFE’s (Spanish railway operator) website for existing services. For potentially possible services using the existing infrastructure, in-vehicle time was estimated based on the commercial speeds of the existing services along the same line. Based on previous empirical analyses (Cambridge Systematics, Inc., 2006; Martín et al., 2014), 19 minutes have been added to each HSR connection in terms of ‘waiting time’. Access-egress time is directly obtained when running the GIS model since HSR stations are connected to the road network.

The methodological approach is based on that applied by Martínez et al. (2014) for the Madrid Urban Region (Madrid Region and the three adjacent provinces). Therefore, a combination of three

---

1. None of the conventional rail (CV) connections were competitive in comparison with the other transport networks since travel times, once the access-egress (from/to the centroids) and waiting times were accounted for (19 minutes were considered as well for CV although this figure should be greater since reliability of the conventional services is poorer than that of the HSR, even more in 1981), were greater than the ones obtained when undertaking the same travel by some of the other transportation modes. For instance, the Albacete – Madrid distance was covered in 1981 in 182' by car and 183' by CV and in 2012 in 150’ by car, 159’ by CV and 103’ by HSR; the Alcázar de San Juan – Madrid distance was covered in 1981 in 114’ by car and 116’ by CV and in 2012 in 91’ by car and 101’ by CV; the Guadalajara – Madrid distance was covered in 1981 in 60’ by road and 71’ by CV and in 2012 in 26’ by road, 64’ by CV and 55’ by HSR.

2. The advantages of taking travel time into account is that it integrates the location of nodes (introducing the concept of the traditional physical distance) and the shape and quality (travel speed) of the infrastructure.

3. In transportation studies, door-to-door user travel time is usually broken down into different components (Hanson, 2004): a) access- and egress-time (that the traveller needs to get to a terminal from the origin or from the terminal to the final destination); b) waiting-time that the traveller spends waiting for the bus/train/plane at the terminal/platform); and c) in-vehicle-time (that the traveller spends in a traveling vehicle).
complementary (location-based) accessibility indicators (see Table 2.1.) evaluated for two time scenarios (1981 and 2012) is proposed. This sequence acknowledges different components of rural metro-adjacent regions spatial structures: a) the extension of the reachable area is measured by a contour indicator (in terms of number of municipalities and opportunities that can be reached within certain TTB); b) the potential for interaction within the urban region is described by a potential (gravity-based) indicator; and c) the performance of those centres leading the rural metro-adjacent regions urban network is evaluated by a competition measure (inverse balancing factors). It is important to mention that this location-based approach was selected instead of a more sophisticated one including person- and utility-based measures since these ones have important disadvantages related to data availability and complexity, restricting applications to relatively small regions and subsets of the population (Geurs and van Wee, 2004).

Nonetheless, five improvements reinforce that methodology:

First, whilst Martínez et al. (2014) only accounted for road network impacts, the hereby proposed methodology evaluates a multimodal transport system by incorporating the HSR. Most of the existing studies on the impacts of HSR fail in using nodes/centroids (usually the main city of the region) as point representation of Eurostat regions (NUTS) and its accessibility value is given to the whole region (Vickerman, 1997; Gutiérrez et al., 1996). Hence, “although activities are particularly concentrated in these urban agglomerations and the competitiveness of the high-speed train is based on quality of service and access times to the chief cities, and that it would seem logical to measure accessibility with respect to such cities” (Gutiérrez, 2001:240), HSR extends its effects to the surrounding areas and consequently any examination of a HSR line must consider a wider geographic area than just the cities, and especially the stations, on the line (Martínez and Givoni, 2012).

Second, a more in depth analysis of the type of activities feasible at destinations for certain travel time budgets is carried out in the present research. Based on previous studies on travel time expenditure, there is no doubt that travel time assigned for ‘non-compulsory’ (shopping or social/recreational/leisure) travel purposes or for access to school/other services (what we call as ‘access to daily services’) is lower than for commuting and these two are lower than the time spent for business trips. Therefore, similarly to Martínez et al. (2014), a first TTB is set in 30 min under the hypothesis that up to this travel time, average individuals undertake all three activities (access to daily services, commuting and business). However, in contrast to the 45 min threshold previously used, this paper distinguishes two different ones: 60 min and 90 min. The relevance for doing that distinction is twofold. On the one hand, because HSR allows individuals being more willing to increase their travel times (see section 2.2.2.). On the other hand, to be able to differentiate between commuting and business (which usually takes place over longer distances/travel times) by considering that over 30 min most travel to daily services do not take place and over 60 min mostly business trips are the only ones taking place (see section 2.2.2.).
<table>
<thead>
<tr>
<th>Spatial Structure Component</th>
<th>Accessibility Measure</th>
<th>Formulation</th>
<th>Variables</th>
<th>Data</th>
<th>Study Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interconnection and extension</td>
<td>Contour measure</td>
<td>[ A_i = \sum \frac{B_j}{t_{ij}} \times O_j ]</td>
<td>( t ): threshold/TTB &lt; 30 min: daily services &lt; 60 min: commuting &lt; 90 min: business</td>
<td>GIS road and HSR networks</td>
<td>11 CLM FUA centres (comparing with the 31 MBC)</td>
</tr>
<tr>
<td>Interaction and cohesion</td>
<td>Potential measure</td>
<td>[ A_P = \frac{P_i}{t_{ci}} + \sum_{j=1}^{n} \frac{P_j}{t_{ij}} ]</td>
<td>( P_i, P_j ): population of area i,j</td>
<td>1981 Census and 2012 Population Register (Available from the Spanish Statistical Office)</td>
<td></td>
</tr>
<tr>
<td>Specialization and city profile</td>
<td>Competition measure</td>
<td>[ A_i = \frac{E_i}{B_i} \times \frac{1}{t_{ci}} + \sum_{j=1}^{n} \frac{B_j}{A_i} \times \frac{1}{t_{ij}} ]</td>
<td>( E_i ): jobs in area i ( W_j ): workers in area i</td>
<td>GIS road and HSR networks</td>
<td>18 Madrid (8) and 21 CLM (9) leading poles</td>
</tr>
</tbody>
</table>

Notes: (1) Cerda (2009: 7); (2) Kotavaara et al. (2011:930); (3) and (4) Adapted (including the self-potential) from Wildgoose et al. (2003:9); (5) In order to evaluate the pure road and rail improvements effect, the mass factor (attraction of the nodes) in the potential indicator was fixed (Bosman-Snow, 2007; Garcia-López, 2012), so that every city/activity centre has the same population in both time scenarios (1981 and 2012) to that of 1981. (6) Coelho-Melhorado et al. (2011) calibrated the travel time exponent from trade data between Spanish provinces and a value of 1.33 was obtained. Sometimes flow data is not available for calibrating the distance exponent and values of 1 or 2 are used to represent the friction of distance; (7) Once the endogeneity issue has been partially addressed by fixing the potential indicator the number of opportunities — population— as that of 1981, determining the impacts brought about only by the improvements in the transport system, this last step aims to understand the current situation of the main CLM urban structure and not to determine whether accessibility changes are due to transport improvements or to population growth, varying population and employment for each scenario. (8) Romero et al (2014); (9) Municipalities with more than 15,000 inhab., and 2,500 jobs in 2012.
Third, a **more accurate impedance** (or distance decay) **function** is used. Whilst Martínez et al. (2014) proposed an exponential formulation based on the German labour market (Reggiani et al., 2011), the hereby proposed methodology uses a power-decay function **based on a recent Spanish case study calibration** (Condeço-Melhorado et al. 2013).

Fourth, the **self-potential issue** is tackled in a better way. Martínez et al. (2014) set in 2 minutes the mean internal travel time regardless city population. Nevertheless, average travel time of internal relationships tends to increase as the size of the city increases (Gutiérrez, 2001). Consequently, in this study internal travel times **have been proportionally estimated with demographic size**, hypothesising that internal relations last 10 minutes in the biggest municipality (Madrid), since it is the travel time between Madrid and its closest municipality, and 1 minute in municipalities 10,000 inhabitants or smaller.

Finally, Martínez et al. (2014) proposed a typology of cities’ capabilities for competing for workplaces and for potential workers by assessing changes in their ranking positions between 1981 and 2011. The first shortcoming of this classification is that rankings are obtained by directly arranging the results of the two **inverse balancing factors** which are not the real accessibility values. Thus, our methodology proposes their **transformation to a potential accessibility measure** by multiplying each balancing factor by the average of the complementary one, in order to express the number of activities within reach (Geurs and van Eck, 2003). The second limitation of Martínez et al. (2014) classification is that better (or worse) place ranks do not necessarily mean greater (or lower) accessibility levels, but that they perform comparatively better (or worse) than the rest of the sample. Consequently, and once the balancing factors have been transformed to a potential accessibility measure (allowing comparisons between scenarios), different types of cities are identified by comparing their accessibility levels with the rest of the area.

### 2.4. RESULTS AND DISCUSSION

As previously mentioned, each of the three accessibility measures allows acknowledging different components of rural metro-adjacent regions spatial structure: a) interconnection and extension, b) interaction and cohesion and c) specialization and city profiles.

#### 2.4.1. The ‘reachable areas’: interconnection and extension

As it could be expected, the multimodal transport network improvement has favoured the enlargement of CLM FUA centres catchment areas between 1981 and 2012 (see Appendix V-Figure A.V.1.), both in terms of the total number of municipalities and the reachable population (see Table 2.2.).
The number of other FUA centres within reach (which is a good proxy to evaluate internal interconnection) and the share of centres which included Madrid in their catchment areas increased as well.

![Table 2.2. - Contour measure analysis, summary of results. Source: authors based on INE (1981 and 2012).](image-url)
For travel times up to **30 minutes**, none of the eleven FUA centres included Madrid in their catchment areas neither in 1981 nor in 2012 and almost none of them could reach other FUA centres in both time scenarios (see Table 2.2. and Figure 2.3.). As well, metropolitan interconnection with other Madrilenian centralities (MIC) is very limited (see Table 2.3.) for this TTB (although a noteworthy improvement has been noted): in 1981 only one FUA centre was able to reach one MIC and in 2012 only the two FUA centres closer to Madrid were able to reach some MIC (on average, 10 MICs were accessible from each one). All this shows that the areas where access to daily services take place are very local and almost non inter-FUA centres mobility is possible. Comparatively, the spatial distribution of the FUA centres throughout a wider territory in contrast to the greater concentration of MICs leads to higher levels of interconnection among the last ones for this TTB (see Table 2.3.): on average, 40% of the MICs could be reached in 1981 from each other increasing to 73% in 2012, while only the 2% of the FUA centres could be accessed in 1981 from each other, slightly increasing this figure to 4% in 2012. In conclusion, a lower polycentrism exists between the main urban centres within rural metro-adjacent regions than in metropolitan areas for access to daily services travel purposes.

### Table 2.3. - Contour measure analysis: comparison between Madrid intermediary cities (M.I.C) and CLM FUA centres catchment areas. Source: authors based on INE (1981 and 2012).

<table>
<thead>
<tr>
<th>Region (see Fig.2.2.)</th>
<th>Type of activity</th>
<th>30' Catchment Area</th>
<th>60' Catchment Area</th>
<th>90' Catchment Area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Municipalities</td>
<td># M.I.C.</td>
<td># FUA centres</td>
<td>Municipalities</td>
</tr>
<tr>
<td>Madrid (31 MIC)</td>
<td>MAD (1)</td>
<td>27</td>
<td>12.4</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>12 road</td>
<td>30</td>
<td>22.5</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td>12 multi</td>
<td>30</td>
<td>22.5</td>
<td>0.6</td>
</tr>
<tr>
<td>CLM (11 FUA centres)</td>
<td>81 road</td>
<td>0</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>12 road</td>
<td>0</td>
<td>1.7</td>
<td>0.4</td>
</tr>
<tr>
<td></td>
<td>12 multi</td>
<td>0</td>
<td>1.7</td>
<td>0.4</td>
</tr>
</tbody>
</table>

(1) Number of municipalities (MIC or FUA centres) that reached Madrid within the considered TTB
(2) Average number of MICs that could be reached from each other MIC or FUA centre
(3) Average number of FUA centres that could be reached from each other MIC or FUA centre

Despite being relatively local (concentrated around the FUA centres), 30 min. catchment areas have been extended during the last three decades in terms of the number of municipalities and population included. On average, FUA centre catchment areas increased by 2.3 times in terms of number of municipalities and by 3.5 in terms of population, being greater in population for the FUA centres closest to Madrid since they extend towards Madrilenian municipalities which have a considerable population. However, it is noteworthy that no differences are found in 2012 between the ‘with’ and ‘without’ HSR scenarios, concluding that HSR doesn’t add competitive connections to the road network for access to daily services.
For travel times up to 60 minutes, only the three FUA centres closer to Madrid were able to reach it in 2012 (two of them already could reach Madrid in 1981), meaning that the linkages with the metropolitan centre for commuting did not substantially improve during the study period, even despite the HSR network (see Table 2.2. and Appendix V-Figure A.V.1.). Metropolitan interconnection with other Madrilenian centralities has also increased: on average, 9% of the MIC was accessible in 1981 from each CLM FUA centre, increasing to 25% of the MIC in 2012 (see Table 2.3.). However, these interlinks are limited to the three FUA centres closer to Madrid.

For both time scenarios, the number of FUA centres that can be reached within a 60 min TTB from each other is also very small (6% in 1981, 15% in 2012 ‘without’ HSR and 17% in 2012 ‘with’ HSR –see
Table 2.3). FUA centres of the Ciudad Real province, due to its high polycentric urban structure (4 FUA centres distributed throughout 19,813 km²) were the ones with higher capabilities to reach other FUA centres (three), registering the greatest improvements since 1981. In conclusion, this general low level of interconnection among FUA centres in contrast to the greater one among MICs, points out as well that commuting polycentric structures are much more noticeable within metropolitan regions than in rural metro-adjacent ones.

Similar to the 30’ TTB, FUA centres have extended their catchment areas for the 60’ TTB between 1981 and 2012 (by 2.3 times in terms of number of municipalities and by 3.5 in terms of population). Consequently, the number of FUA centres from which each municipality can be reached have also increased (see Figure 2.3.) over time and is also greater than for 30’ TTB: whilst for the 30’ TTB the maximum overlapped area was accessible from two FUA centres, for the 60’ TTB this value increased from 4 in 1981 to 5 in 2012.

Whilst the road network shapes the territory in a relatively continuous way, space is becoming more discontinuous due to the HSR network and ‘islands’ of greater accessibility emerge around the stations. In the considered study area, this situation starts being depicted for the 60’ TTB (although only for two peripheral HSR cities: Albacete and Cuenca). Consequently, HSR only allowed a greater regional interconnection in two of the FUA centres in an isolated position.

For travel times up to 90 minutes, apart from the four FUA centres closest to Madrid being able to reach the metropolitan centre in 2012 (three of them already included it in 1981 in their 60 min. catchment areas), the improvement is remarkable for two distant FUA centres (Ciudad Real and Cuenca) which extended their reachable areas towards Madrid municipality in 2012 thanks to the HSR (see Table 2.2. and Appendix V-Figure A.V.1.), conspicuously opening up the number of opportunities available for business purposes (see Table 2.2.). Although less notoriously than for the 60’ TTB, metropolitan interconnection with other Madrilenian centralities has also increased for 90 min travel time: on average, 27% of the MIC was accessible in 1981 from each CLM FUA centre, increasing to 51% of the MIC in the 2012 multimodal scenario (see Table 2.3.). While in both time scenarios these greater interlinks with the whole metropolitan region were limited to the three FUA centres closer to Madrid, in 2012 a greater number of FUA centres extended their catchment areas towards the Madrid Region.

Greater regional interconnection levels (in terms of the number of reachable FUA centres) are achieved for this travel purpose: whilst only 18% of the FUA centres could be accessed in 1981 within 90 min from each other, this figure increased to 35% in 2012 ‘without’ HSR and to 41% in the 2012 ‘with’ HSR scenario (Table 2.3.).

It is important to bear in mind that although the number of interconnections in 2012 for this TTB with the rest of the FUA centres (41%) are not very different with that ones with the MICs in terms of municipalities, double opportunities in terms of population are available within the Madrid region.
The effects of the HSR network are more noticeable for this TTBs: on average, the number of reachable FUA centres from each other increased between 1981 and 2012 in 2.5 centres (while that increase was only in 1.8 centres if only the road network is considered). Consequently, it is for business travel purposes that the competitive advantages added by the HSR, in contrast to the road network, are more noticeable.

For business purposes, between 1981 and 2012 (‘with’ HSR scenario) FUA centres extended their catchment areas by 2 times in terms of number of municipalities and by 6.3 in terms of population. This results in much larger overlapped areas (see Figure 2.3.), meaning that a greater number of municipalities have more opportunities available (more FUA centres could be accessed) for business purposes.

To sum up, thanks to multimodal transport system developments within rural metro-adjacent regions, catchment areas have experienced a scale shift, resulting in greater interconnection levels: a) with the Madrid Region, mainly towards the core city (being the improvements more noticeable for high TTB and with the HSR playing a key role) and to a lesser extent to the Madrilenian medium-sized intermediary cities (essentially for municipalities closer to the metropolis); and b) within the rural region itself for 60’ travel time upwards (in contrast to the greater metro-region internal cohesion for all travel purposes).

2.4.2. The potential for interaction and cohesion

The potential indicator shows a similar general increase of accessibility between 1981 and 2012 in CLM and in Madrid Region. Considering only the road network, the mean value increases 47.6% for the Madrid Region and 46.7% for CLM. This increase is reinforced by HSR in CLM, to 51.0%, and almost maintained constant in Madrid, to 48.0%. The effect of the HSR is especially important in those distant cities with a HSR station (between 4 and 11%) and their immediately surrounding municipalities (see Figure 2.4.).

Apart from an increase in the mean and standard deviation values of the potential accessibility indicator, the coefficient of variation1 slightly decreased in CLM from 63.3% in 1981, to 59.7% in 2012 when considering only the road network, and to 57.6% in 2012 when taking into account the multimodal transport network (see Table 2.4.). These lower values indicate that regional disparities among CLM municipalities diminished during the last three decades (a lower number of municipalities differs from the potential accessibility regional average). Nevertheless, the high values for the Moran’s i in both time scenarios (see Table 2.4.) demonstrate that accessibility improvements are spatially clustered in a few municipalities: the FUA centres (Figure 2.4.b. and 2.4.c. clearly depicts that concentration −see the

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1 Due to significantly different mean values of the potential accessibility indicator for 1981 and 2012, dispersion cannot be directly assessed by just comparing the standard deviation of both scenarios.
darker colours of the key). The z-scores and p-values indicate that null hypothesis (Complete Spatial Randomness) can be rejected. This outstanding concentration of greater potential accessibility levels in a limited number of centres already appeared in 1981 although it has been emphasized during the last three decades.

**Figure 2.4.** - Potential accessibility indicator. **Fig. 2.4.a.** - 1981 road network scenario. **Fig. 2.4.b.** - 2012 road network scenario. **Fig. 2.4.c.** - 2012 road and HSR networks scenario. *Source: authors.*
On top, whilst some authors argue that HSR could favour the further concentration of economic activity in privileged locations, the HSR station cities, and consequently may lead to increasing (rather than reducing) regional disparities (Vickerman et al., 1999; López et al., 2008; Kotavaara et al., 2011), results show that the HSR has not worsened the 2012 concentration when only considering the road network (see Table 2.4.).

Three CLM FUA centre patterns can be concluded:

a) Those less than 100 km distant from Madrid (Illescas, Guadalajara and Toledo). These municipalities, partly because of their proximity to the metropolitan centre and partly because of the outstanding improvement of the road network in the Madrid surroundings, concentrated the highest interaction levels and experienced the greatest potential accessibility increase between 1981 and 2012 (81.0%, 33.1% and 16.6% respectively). However, HSR had almost no influence on this potential accessibility increase (81.3%, 33.7% and 17.1% respectively when taking road and HSR into account).

b) Those more than 100 km distant from Madrid, without HSR station and located along important national corridors, built or upgraded during the 1980s (Alcázar de San Juan, Talavera de La Reina, Tomelloso and Valdepeñas). These municipalities, thanks to this road network improvement, experienced remarkable potential accessibility increases (between 6 and 19%) between 1981 and 2012. HSR has not influenced their potential for interaction with the rest of the region.

c) Peripheral ones with HSR station (Ciudad Real, Puertollano, Cuenca and Albacete). Due to their geographical location, these municipalities experienced slight potential accessibility changes between 1981 and 2012, less than 10% considering only the road network. Reversely, they benefited more from HSR than from road, most of them more than doubling their potential accessibility increase when considering both road and HSR.

Table 2.4. – Potential accessibility analysis, summary of results for the CLM region. Source: authors based on INE (1981 and 2012).

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Max</th>
<th>Min</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Coef. of variation</th>
<th>Moran’s i</th>
<th>z-score</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>‘81_road’ scenario</td>
<td>88,978</td>
<td>3,509</td>
<td>13,084</td>
<td>8,280</td>
<td>63.3%</td>
<td>0.613</td>
<td>55.98</td>
<td>0.0000</td>
</tr>
<tr>
<td>‘12_road’ scenario</td>
<td>91,999</td>
<td>5,576</td>
<td>19,193</td>
<td>11,461</td>
<td>59.7%</td>
<td>0.842</td>
<td>76.55</td>
<td>0.0000</td>
</tr>
<tr>
<td>‘12_multi’ scenario</td>
<td>93,935</td>
<td>5,660</td>
<td>19,755</td>
<td>11,377</td>
<td>57.6%</td>
<td>0.833</td>
<td>75.76</td>
<td>0.0000</td>
</tr>
</tbody>
</table>
2.4.3. Specialization and city-profile

In order to assess competition effects between actors, a third accessibility indicator was applied to the Madrid Region and the Castilla-La Mancha Leading Poles (see section 2.3.1. and Figure 2.2.). This allows understanding not only the capability of a place (working population) for accessing the available opportunities (employment), similarly to what potential measure does, but also the capability of its opportunities (employment) for being accessed from the rest of the territory (workers). Whilst in assessing these competition effects it is necessary to take into account all the leading poles (within both the Madrid and CLM regions), the results analyses are focused only on the CLM ones.

In absolute terms, between 1981 and 2012 and in both ‘without’ and ‘with’ HSR scenarios, all the leading poles improved their accessibility to jobs and to workers (Figures 2.5. and 2.6.) since not only travel times have been reduced thanks to the transport improvements, but working population and jobs have considerably grown during the last three decades.

Nevertheless, when looking at the HSR competition effects (see Figure 2.6.), two conclusions can be drawn. First, that municipalities located more than 100 km from Madrid and with a HSR station as well as those more than 200 km and close to a HSR station, are the only ones benefiting from the HSR network in regards to their accessibility to jobs (because they are able to reach a greater number of opportunities, mainly at Madrid). However, exactly for that reason, the capabilities of firms to access working population has decreased due to HSR, since the better access to jobs lead to greater competition with other companies trying to hire the same workers. Second, for the remaining municipalities (not benefiting from the access to the HSR network) this competition with other firms (mainly the Madrilenian ones) is lower, allowing an increase in firms’ capabilities for being accessed, although at the expense of a slightly worst access to jobs (the working population competes for a limited number of employment since their ‘job-search’ areas are more limited/local). Therefore, as some scholars already hypothesised (Cañizares, 2007), CLM can benefit from the competitive advantages of high-capacity infrastructures, although those ones connecting the region through a reduced number of nodes may not contribute to the emergence of a more polycentric urban structure since they reinforce only a very limited number of centres.

The outcome of these calculations taking into account the multimodal network (Figures 2.5. and 2.6.) is used to define a typology of the CLM ‘leading poles’ in terms of their current capabilities for competing for workplaces and for potential workers as well as their changes over the last three decades. At this point, it is necessary to notice that, when comparing trajectories, a relative decrease (increase) in accessibility between 1981 and 2012 does not mean lower (greater) absolute accessibility levels, but that the leading pole is performing worse (or better) than the rest of the sample.

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1 Not taking into account the possible competition between actors would have resulted in less accurate conclusions, since “the ease with which a firm is able to recruit new employees depends not only on the absolute number of potential employees in the surroundings of the firm’s location, but also on the number of other firms that is trying to employ the same persons” (Willigers et al., 2003:9).
A. **Type I. Optimizing Leading Poles** are characterised by accessibility levels in 2012, both to jobs and workers, greater than the regional average. This type of centres accounts for considerable concentrations of working population and employment. Besides, this would mean that municipalities of the immediate surroundings have a low number of workers competing for the jobs offered at these Optimizing Leading Poles and/or a low number of firms trying to recruit the potential workers residing at them. Four of the five CLM capital cities (Albacete, Guadalajara, Cuenca and Ciudad Real) and the biggest non-capital city (Talavera de la Reina) are included in this typology, and all of them already had these greater accessibility levels (than the average) in 1981. Municipalities classified under this typology have experienced the most varied trajectories between 1981 and 2012: while the two most populated (Albacete and Talavera de la Reina) decreased their relative capabilities to reach jobs and increased that ones to reach workers, the other three provincial capital cities (Guadalajara, Cuenca and Ciudad Real) followed totally opposite trajectories. The CLM regional capital (Toledo) followed a similar trajectory than this last subgroup, but its accessibility to workers in 2012 decreased to levels below the average, having changed from type I in 1981 to type III in 2012.

B. **Type II. Balanced second-order leading poles** are characterised by accessibility levels in 2012, both to jobs and workers, lower than the regional average. This type of centre have balanced concentrations of working population and employment. Besides, they are close to other Leading Poles with a high number of workers competing for the jobs they offer and/or a considerable number of firms trying to recruit the potential workers residing at the Leading Pole. Small municipalities at intermediate distances from the metropolitan centre (Villarrobledo, La Roda, Manzanares, La Solana, Daimiel and Tarancón) are included in this typology (traditional agricultural sub-regional poles). All of them except one (Villarrobledo) already had in 1981 this lower access than the average and apart from the closest one to Madrid (Tarancón), all others followed similar trajectories between 1981 and 2012, decreasing both their relative accessibility to jobs and workers.

C. **Type III. Residential-specialized leading poles** are characterised in 2012 by a greater accessibility to jobs and a lower accessibility to workers, than the regional average. This profile is the consequence of being located close (in terms of travel time) to major ‘employment centres’ which have a considerable number of opportunities (jobs). Thus, the capabilities of the workers to access those ‘employment centres’ are outstanding but due to the noteworthy competition of local firms for hiring people with the ones of the surroundings it results in lower capability levels for being accessed. The closest municipalities to the metropolitan centre (Azuqueca de Henares, Toledo, Illescas and Seseña) are included in this typology. None of them, except one (Seseña) were classified under this typology in 1981. Type III leading poles (with the exception of the biggest one: Toledo) followed similar trajectories between 1981 and 2012, increasing both their relative accessibility to jobs and to workers.
Figure 2.5. - Competition accessibility indicator: absolute (including the Madrid Region Leading Poles) and relative values. Source: authors.
Figure 2.6. - Competition accessibility indicator: Types of Leading Poles regarding their performance in 2012 (multimodal transport network). Source: authors.
D. **Type IV. Employment-specialized leading poles** are characterised in 2012 by a lower accessibility to jobs and a greater accessibility to workers than the regional average. This profile is the consequence of being located (in terms of time) close to municipalities which have a limited number of jobs and/or important shares of working population. Thus, the capabilities of the firms for being accessed by workers residing in the surroundings are outstanding. Conversely, the noteworthy competition for jobs with the ones offered by the surrounding municipalities results in lower accessibility levels to jobs. The most distant CLM leading poles from Madrid (Valdepeñas, Puertollano, Hellín and Almansa) and two other ones at intermediate distances (100-200km) and over 30,000 inhab. (Alcázar de San Juan and Tomelloso) are included in this typology. All of them (with the exception of Tomelloso) followed similar trajectories between 1981 and 2012, decreasing their relative accessibility to jobs and maintaining almost constant their capabilities for accessing workers.

2.5. CONCLUDING REMARKS

Motivated by the need for an in-depth understanding on the impacts of improved multimodal transport systems within rural metro-adjacent regions, which have acquired a special concern in European policies, this paper analyses accessibility changes in the Spanish case study of Castilla La Mancha, a rural region highly influenced by the Madrid Metropolitan Area, in order to discuss the generalised EU hypotheses that transport investments support the development of polycentric and balanced urban systems.

From a methodological point of view, this paper reinforces the usefulness of accessibility analyses in characterising urban systems of rural metro-adjacent regions. While some studies already concluded these capabilities of accessibility for explaining urban structures, the main contribution of this paper is the proposal of an improved diachronic, combined/sequential and multimodal methodological approach to understand three spatial features of these rural metro-adjacent regions: first, integration and interconnection; second, interaction and territorial cohesion and third, competition and city-specialization. The last aim of the method is to explain the emerging polycentric urban systems (that EU policies are reinforcing) favoured, among others, by transport system investments.

The main conclusion of this research is that improved multimodal transport networks, partially as a result of the change from a national investment rationale (with the objective of linking together the main national cities/metropolises) to a ‘national-regional’ one (seeking to promote also the internal interconnection of regions) and favoured by the European Structural Funds, are beneficial for rural metro-adjacent regions. This benefit is twofold: first, the reinforcement of a polycentric territorial system of medium-sized and small cities which function as engines of growth for regional economic development, and second, the improvement of the regional internal cohesion.
This general/main conclusion can be broken down in more specific ones in regards to each of the abovementioned three spatial features:

First, results show that improvements in the transport system have greatly influenced the enlargement of catchment areas (leading to longer action radius of agglomeration economies). Differences in the opportunities opened up (accessible facilities/population from each FUA centre) are observed, on the one hand, in regards to travel purpose (or TTB): while the reachable opportunities for access to daily services are concentrated around the centres (30 minutes catchment areas are very local) and no inter-FUA polycentrism is possible in rural metro-adjacent regions, intra-regional interconnections increase slightly for commuting (up to 60 minutes travel time) and substantially for business (up to 90 minutes travel time) travel purposes. Moreover, this research has demonstrated that due to HSR stations, discontinuous catchment areas (‘islands’ with enhanced levels of accessibility) emerge in rural metro-adjacent regions from 60 minutes TTB upwards. Besides, metropolitan integration has also being reinforced, mainly towards the core city (regardless the proximity to it) and to a lesser extent to the medium-sized intermediary cities of the metropolitan region (essentially those regional areas closer to the metropolis). In this last sense, whilst no improvement has been recorded for small travel times, half of the main regional centres are able to reach the metropolitan centre for business travel times (doubling that one of 1981), the HSR playing a key role in this metropolitan interconnection. Rural metro-adjacent regions' catchment areas show as well differences with those ones of metropolitan areas, being the last ones more internally cohesive for all travel purposes, while within rural metro-adjacent regions internal cohesion only starts being significant for commuting and business (high TTB).

Second, the improved multimodal high-capacity transport network has given rise to greater capabilities for interaction, some FUA centres having acquired (provincial capitals and HSR cities) similar potential accessibility levels as municipalities much closer to the metropolitan central city. Thus, interaction and interdependence are not only influenced by metric distance. Besides, transport improvements have helped decreasing regional disparities within rural metro-adjacent regions although they are spatially clustered in a low number of municipalities: FUA centres. Finally, in terms of interaction, HSR has a greater impact on rural metro-adjacent regions than on metropolitan areas.

Third, the competition for jobs and for workers shows how certain places with relatively similar morphological features (in terms of size) adopt different profiles, specialising in attracting and/or emitting workers and thus reinforcing their role as employment and/or residential centres. These results are extremely useful since not accounting for competition may lead to inaccurate or even misleading results, although regional distributions do not radically change with the ones obtained from the potential analysis. In particular, competition effects nuance the effects of the HSR on the rural metro-adjacent region dynamics. In this last sense, while the potential indicator shows a general increase of
accessibility levels, differences arise among centres in their accessibility to jobs and workers when including competition in the evaluation of the HSR network.

In broad terms, among the centres of a certain population and employment size (leading poles), different city-networks can be identified: first, the biggest ones with direct access to the HSR network, regardless their distance to the metropolitan centre, consolidate as hubs with outstanding capabilities for accessing jobs and for attracting workers; second, the medium-sized and small cities closest to the metropolis which consolidate as residential centres with important accessibility levels to jobs and but not so good performance for attracting to workers; third, medium-sized and small cities at intermediate distance from the metropolis with traditional capabilities in organizing their surrounding rural territory.

From a different perspective, it is important to bear in mind that this research has considered all roads segments and all HSR station-to-station combinations, independently of the actual existence of transportation services, as it is commonly done by most accessibility studies. While for the road network it is appropriate not to consider access constraints apart from the existence of an infrastructure, for the HSR network, future analyses should also take into account the existence and frequency of services, since they are the ones truly facilitating the use of this transportation mode. Therefore, apart from providing the infrastructure other policies need to be implemented to best take advantage of the already built infrastructure: such as increasing the frequency of services or reducing the ticket prices.
Chapter 3

Understanding Mobility Patterns

1. INTRODUCTION

Whereas the accessibility concept (see Chapter 2) refers to a potentiality (the facility for accessing opportunities), the mobility one refers to a reality (real movements for accessing opportunities). Nevertheless, the terms are interrelated and improvements in accessibility (to employment, service or leisure) affect increased mobility (Condeço-Melhorado, 2011), making people less constrained to what is nearby (Frändberg et al., 2005). Similarly to accessibility, mobility has acquired an essential role in assessing territorial impacts of transport networks, more so during the last decades due to the profound transformations registered in the most urbanized areas (especially relevant are those ones in daily commuting). Thus, mobility analyses provide planners and decision makers with the necessary tools to evaluate existing and future infrastructures. But also mobility is becoming central in policies. In that sense, many European countries are also developing policies to facilitate and promote a mobile labour force, in order to promote productivity and contribute to sustainable economic growth (for example the Europe 2020 strategy).

Apart from being conditioned by the transport network, there is a reciprocal relation between mobility and the spatial distribution of land-uses. In fact, mobility has been considered as a result of the spatial mismatch between supply –activities- and demand –population (Potrykowski and Taylor, 1984). Especially relevant are mobility analyses aiming to characterize the new urban structures and dynamics within metropolitan contexts. The new metropolitan urban systems, characterized by an outstanding scale shift, fragmentation, specialization and increasingly complexity of settlement structures (polycentrism), particularly within the new peripheries, are as well a determining factor for mobility (Champion, 2001). In general terms, the emerging territorial model has resulted in: a) a greater number of flows per person; b) increasingly varied travel purposes; c) longer travel distances; d) outstanding dependence on private car (García, 2008). This is especially in contrast with the traditional model in which flows were predominantly work-related and spatially (hierarchical relations form peripheral areas/sub-centers towards the metropolitan center) and temporally (peak hours) concentrated. On the
contrary, in the postfordist era, due to population dispersion and economic decentralization, the daily network of interrelations stretches out geographically (Urry, 2002; Ellegård and Vilhelmsson, 2004; Vilhelmson, 2007) and the distribution of flows becomes more diversified and networked (less hierarchical). Besides, due to the flexibilization of working times (Green et al., 1999) and the increasing relevance of other travel purposes, flows are more distributed during the day. This obviously has a relevant implication in the provision of transit and the more complex/singular mobility patterns make it difficult for public transport services to answer travelers’ requirements.

Despite the fact that these greater mobility levels are a global process, during the last years the analysis of changes within rural territories has acquired a considerable importance in contrast to the traditional attention paid to migration. In Spain, whereas national out-commuting increased 8.7% between 2001 and 2011 (from 5,144,617 to 5,590,840 trips), it increased 34.5% at CLM rural region (from 172,866 to 232,475). In terms of working population, between 2001 and 2011, out-commuting was almost stable in percentage terms in Spain (31.5% and 31.9% respectively) while it increased in CLM (from 26.7% to 31.5%, respectively). During the last decade, housing reallocation rates have also been significant both for Spain (65.9%) and CLM (115.6%). Nevertheless, regional increases in contrast to the national ones are more significant for out-commuting (almost 4 times greater for CLM than for Spain) than for housing variations (1.8 times greater).

While it is not the intention of this dissertation to clarify them, apart from transport network developments and urban spatial reconfigurations, a complex set of factors of the current metropolitan transformation has direct or indirect repercussions on the overall mobility (and specifically on the labour one): the economic revitalization in the globalization era, the transformation in the production model (post-fordism) and the new business logics (new intra-firms’ organization), changing consumption patterns, technological improvements (including those in transport systems) and the ICT revolution, the cultural globalization or socio-demographic and cultural transformations (an evolving demographic regime characterized by the aging of population, the ethnic and cultural diversity and an increasing variety of households’ composition types or the new lifestyles).

Overall, mobility stands out as an accurate variable to characterize functional relations and the underlying spatial configuration of rural metro-adjacent regions. Thus, once the morphological dimension has been explored and the access capabilities of rural metro-adjacent regions have been measured (see Chapter 2), it is time to look at the real use of their transport systems, that is, the relational dimension by following a mobility approach. Therefore, this chapter seeks to understand mobility patterns within rural metro-adjacent regions. Its last aim is twofold. First, to examine the appropriateness of a mobility approach in explaining reconfigured urban systems and their changes in

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1 “It is undeniable that in Western Europe and in many other countries of the developed world the demographic regime is now very different from that of 30–40 years ago and is continuing to evolve (Champion, 1998). Among the main differences in patterns of population change are slower national population growth, higher life expectancy, markedly lower fertility, increasing cohabitation, rising levels of couple separation, surging net immigration and faltering net internal migration to the larger metropolitan centers (Hall and White, 1995)” (Champion, 2001:657).
terms of centrality and attractor capabilities of the main regional cities (in contrast to the traditional ones of the metropolitan centre and subcentres). Second, to determine to what extent metropolitanization and state rescaling processes have possibly influenced on their spatial organization (by fostering the consolidation of regional centralities and by transforming traditional accephalic and leaderless regions into incipient polycentric ones) and led to a greater intra-regional cohesion.

In doing that, the chapter is divided in two sections. Section 2 focuses on changes in commuting patterns occurred since the 1980s. This approach is based on the assumption that commuting is a good indicator to acknowledge the existing relations among different territories (as widely demonstrated in literature). Additionally, the relevance of focusing on out-commuting information is that since it has become a valuable alternative to migration (Green et al., 1999; van Ham, 2002), the long-distance commute can bring about both increased employment and cultural opportunities for those living in lagging regions (Nuvolati, 2007) benefiting from a cheaper residential area or a more attractive neighbourhood (Sandow, 2008).

Another reason why many scholars have focused on commuting is that its data is generally the most elaborate, reliable, and relevant interaction information available (Burger et al., 2014). While the hereby analyses (for the central area of Spain) are based on origin and destination out-commuting information (inter-municipal commuting relations) included in the 1981, 2001 and 2011 Spanish censuses, by the beginning of the research (in 2011) the last Census was being elaborated and its data were not publicly available until late 2013. A first approach to the changing commuting patterns was addressed by analyzing 1981 and 2001 Census data and the 2012 information collected from an own-elaborated survey (which was addressed to a sample of the regional households). A detailed description of the methodology, data sources and results is gathered in the Paper A.5 (see Appendix VI): MOHINO, I., UREÑA, J.M. and SOLÍS, E. (InPrint1), “Patrones de Movilidad en Áreas Distantes de Regiones Metropolitanas Multicéntricas: Radialidad vs. Tangencialidad. El Caso de Castilla-La Mancha Respecto a la Región Metropolitana Madrileña”, Boletín de la Asociación de Geógrafos Españoles 69 (pages not available yet). Once the 2011 Census was published (although with some limitations as explained in section 2.3.2), that preliminary analyses were updated and results gathered in MOHINO, I., SOLÍS, E. and UREÑA, J.M. (Mimeo), “Changing Commuting Patterns in Rural Metro-Adjacent Regions: the case of Castilla-La Mancha (Spain)”, submitted to Regional Studies (accepted with minor revisions).

However, not only commuting is relevant in determining mobility patterns but also other less recurrent forms of work-related travel, such as business trips (which in the globalization era are consolidating as an essential component of daily mobility). Besides, workers’ socio-economic characteristics (such as income or education level) have a significant effect on the spatial distribution of functional linkages. It is therefore crucial to take both factors (‘multiplexity’ of travel purpose and

1 It is expected to be published by Fall 2015.
‘Individual level’ heterogeneity) into account to accurately characterize rural metro-adjacent regions’ urban structures. In that sense, a second approach (complementary to the previous one) is proposed in section 3 which presents the paper **MOHINO, I., UREÑA, J.M. and SOLÍS, E. (Mimeo), “The Influence of Education Level in Rural Metro-adjacent Regions’ Work-related Travel Patterns: The Case of Castilla-La Mancha (Spain)”, submitted to Rural Studies (Under review).** It aims to explain reconfigured urban structures within rural metro-adjacent regions’ based on an examination of the current spatial patterns of commuting and business travel. These patterns are also compared for different working population profiles regarding their education level, to investigate how rural metro-adjacent regions offer different opportunities for average working population and other highly-skilled workers. A diachronic analysis has not been possible in this case due to the lack of data for previous time scenarios. Preliminary results about the influence of travel purpose and education level on the spatial distribution of functional linkages have already been published and included in Paper A.6 (see Appendix VIII): **MOHÍNO, I., UREÑA, J.M. and MARTÍNEZ, H. (2014), “Relaciones Funcionales de Profesionales Altamente Cualificados en Áreas Distantes de Regiones Urbanas Multicéntricas: El Caso de los Ingenieros de Caminos en el Contexto Madrileño”, Scripta Nova XVIII (488), available online at: http://www.ub.edu/geocrit/sn/sn-488.htm.**
2. CHANGING RURAL METRO-ADJACENT REGIONS’ COMMUTING PATTERNS

This section presents the paper:


Abstract. This paper describes changing commuting patterns within rural regions gradually integrated into metropolitan dynamics and recently re-configured by state rescaling processes. This study focuses on Castilla-La Mancha (Spain), a rural region under Madrilenian influence, between 1981 and 2011. The empirical results show that these regions are a) becoming hybrid territories, changing from predominantly rural territories into areas that exhibit mixed rural-metropolitan behaviours; b) increasingly influenced by metropolitan overflows, which are predominantly integrating non-centrality municipalities; c) transforming their urban spatial structures from leaderless models to incipient polycentric ones; and d) experiencing a commuting reconfiguration towards multidirectional patterns.

Keywords. Urban network, Commuting, Polycentric Urban Regions, Rural regions, Metropolitan influence, State Re-scaling.

2.1. INTRODUCTION

In the context of global economic and socio-cultural changes and monocentric metropolitan areas becoming polycentric (Kloosterman and Musterd, 2001; Lambooy, 1998), this paper contributes to the literature on contemporary spatial reconfigurations by analysing Polycentric Urban Regions (PUR) at the supra-local scale by characterizing their functional linkages (and their relations with the underlying city network) beyond their immediate surrounding territories and towards adjacent rural regions.

The relevance of engaging with these rural regions relates to the multiple transformations that have occurred in recent years. First, a rural population renaissance ('urban-rural shift', 'turnaround' or 'counterurbanisation') has been taking place since the 1960s in the United States and Western Europe (Long and de Are, 1988; Renkow and Hoover, 2000). This migration increase from the city to the

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1 Within the scope of this paper, a conceptual distinction is made between the terms ‘area’ and ‘region’; the latter refers to administrative regions, i.e., the territorial units (with marked boundaries) into which a country is divided.

2 The transformations in rural regions have included population growth, changing production dynamics, the integration of the rural dimension into national society, the cultural dimension, the role of the state and the social and political role of particular actors. In Europe, these transformations have been partly motivated by the significant structural transformations of the policy for rural areas during the 1980s, which advocates structural funds to strengthen economic and social cohesion and to diminish disparities between the most and least developed regions of the EU member states (Ward and McNicholas, 1998).
countryside has blurred the historical rural-urban dichotomy (Woods, 2009). Nevertheless, previous studies have been constrained to rural districts adjacent to the principal city (the peri-urban area; see Figure 3.1.), and only a few recent scholars have emphasised the rural territories surrounding peri-urban areas (Piorr et al., 2011; Ravetz et al., 2013). Second, recent studies that complement traditional research largely restricted to migratory flows (Milbourne and Kitchen, 2014) have found reconfigurations of rural commuting (Green and Meyer, 1997; Mitchell, 2005; Schindegger and Krajasits, 1997). However, “outside major agglomerations, the understanding of the multidirectional nature of commuting patterns is more limited” (Harris et al., 2008:13). In that sense, rural regions adjacent to metropolitan areas are an especially interesting research topic because they are hybrid territories that are neither fully integrated into metropolitan dynamics nor totally rural and self-contained.

In these transformations within rural regions adjacent to PURs, two sets of processes have been crucial. First, metropolitanization processes have resulted in the growth and expansion of PURs, which are progressively overflowing into rural regions. However, the literature has focused on large, global cities and urban regions (Harris et al., 2008; van Heur, 2010). Second, the rescaling of states has led to new forms of urban governance by increasing 'bottom-up' strategies. This spatial and scalar reorganisation equips intra-national governments (in regions and municipalities) with political tools to attract external capital on a global scale to improve transport infrastructures and public facilities and to promote regional competitiveness (Brenner, 1999, 2004). Nevertheless, the literature on the rescaling of states has focused on socio-political issues and been confined to major metropolitan regions, referring to new forms of urban governance, as if these forms were solely urban phenomena (Cheshire et al., 2007; Goodwin, 1998).

In summary, the aim of this broader approach is twofold. On the one hand, we seek to understand functional interactions within the restructured rural administrative regions adjacent to metropolitan regions (what we call ‘rural metro-adjacent regions’) in relation to their underlying urban spatial configurations. On the other hand, we examine the influence of metropolitanization and state rescaling processes in shaping these regions’ functional linkages. In doing so, this research focuses on central Spain, specifically on the recently created Castilla-La Mancha (CLM) administrative region that is adjacent to the Madrilenian region, in which metropolitan processes have already begun to have a

1 The following factors partially explain the territorial transformations in metropolitan areas and the consequent mobility: a) the economic growth and revitalization that, in the context of globalization, have led to outstanding urban growth and to greater mobility levels; b) the new forms of rationalisation of production that have resulted in economic decentralization and the consolidation of new employment centres in the metropolitan periphery, thus fostering the configuration of a polycentric urban model and diversifying functional linkages (from hierarchical flows directed towards the metropolitan centre to multidirectional flows); and c) transport system investments (alongside the spreading usage of ICTs), which result in a scale shift in traditional metropolitan areas, which extend their boundaries over a wider territory.

2 While a set of complex processes result because of metropolitanization and the rescaling of states, this paper’s argument is oriented towards the consequent development of economic and transport policies (European funding, improved transport networks, lower taxes than in metropolitan regions, etc.), which foster investments in better transport infrastructures and public works facilities, thus promoting regional competitiveness. Nevertheless, the paper does not explicitly focus on economic and political issues, nor does it intend to focus on governance, though their possible implications will be presented as part of the arguments.
spillover effect (Mendez and Rodriguez, 2007; Valenzuela, 2010). CLM commuting links in 1981, 2001 and 2011 provide the experimental data that support this research.

The remainder of this paper is organised into the following four sections: a) a literature review on the connections between urban systems and functional relations, with a specific focus on rural regions and the influence of metropolitanization and state rescaling processes; b) the case study, data sources and methodological approach; c) a discussion of the evolving out-commuting patterns for the CLM region; d) a re-delimitation of the CLM Functional Urban Areas; and e) a presentation of our conclusions.

2.2. THEORETICAL BACKGROUND

Contemporary studies on urban systems argue that the traditional monocentric model, the dominant metropolitan form in Western Europe that is characterized by a clear distinction between the main city and suburban areas ('urban-rural dichotomy'), is increasingly inaccurate because a PUR configuration has been emerging since the 1970s in the most globally urbanised areas (Derudder et al., 2012; Hall and Pain, 2006; Lambregts, 2009). PURs (Figure 3.1.) are characterised by decentralised settlement patterns resulting from the relocation of economic activities to new suburban centres that maintain significant connections with the metropolitan centre (Champion et al., 2009; Dieleman and Faludi, 1998b; Garreau, 1991; Richardson, 1988). More recently, improved communication and transportation systems, together with the increase in multi-locational firms, have led to a conspicuous scalar shift in metropolitan systems towards the wider context of the 'Rural-Urban Region' (the 'peri-urban' area and rural hinterland) (Figure 3.1.). This shift also results in the functional integration of surrounding, but historically autonomous, medium-sized cities ('Historic Administrative Cities') into the metropolitan network (Hall and Pain, 2006; Lambregts, 2009; Solís et al., 2015).

Urban systems have also witnessed considerable functional transformations, with mobility reorganisation being dependent on the sub-centre's type, size and proximity to the main city (Aguiléra and Mignot, 2004). Because the central PUR cities have lost their primacy, functional relations are not only hierarchical and unidirectional towards them but also multidirectional and spatially discontinuous between the metropolitan centre and its wider surrounding territory and within these more distant areas (de Goei et al., 2010; Parr, 2005; van der Laan, 1998). In previous research, the magnitude and direction of these flows have been analysed as a means of delineating sub-regional housing and labour markets (Burger et al., 2011; Hincks, 2012). In order to do this, it is first necessary to determine the interaction capabilities (in terms of emitting or attracting flows) of the PUR sub-centres and, second, to delineate their dependencies with the metropolitan centre or other regional territories (what we call 'openness') or with other areas within the same region (what we call 'territorial cohesion').
Two additional research topics are found within the literature on functional relations. The first type assesses the sustainability of new polycentric and dispersed configurations by examining travel distances and times (Cervero and Wu, 1997; Gordon et al., 1991; Schwanen et al., 2001) to clarify whether present urban patterns facilitate the ‘co-location’ hypothesis (reducing travel-to-work flows) or, conversely, create ‘excess commuting’ (Ma and Banister, 2006). The second type identifies the impacts of socio-economic variables (Giuliano and Gillespie, 1997; Titheridge and Hall, 2006; van de Coevering and Schwanen, 2006), which, together with urban forms, land uses and transportation networks (Cervero and Kockelman, 1997; le Néchet, 2012), explain the observed variations in mobility. Nevertheless, although aware of their relevance, this paper does not attempt to shed light on these topics; thus, our empirical analyses do not investigate them.

There are two main driving forces underpinning the changes to contemporary urban systems (de Goei et al., 2010).

First, the increased flexibility and mobility of households and firms, which are caused and made possible by advances in transportation and communication. In this spatial restructuring, rural metro-
adjacent regions\(^1\) (Figure 3.1.), towards which the principal city spreads its influence, play a key role. The changing composition of rural regions has long represented a significant research topic by mapping flows, mainly migration, into and out of rural places (Findlay et al., 2001; Mitchell, 2005; Nutley, 2005) and by determining the socioeconomic profiles of rural populations (Boyle and Halfacree, 1998; Milbourne, 2009; Stockdale, 2006). However, in contrast to migration, commuting has acquired a significant role within contemporary society as a substitute for relocation and has become more common. It has been associated with alternative time-space strategies, which allow people to remain local while accessing opportunities that are more distant (Green et al., 1999).

Nevertheless, there is a considerable lack of understanding about mobility within rural metro-adjacent regions, which cover a wider territory than that of the Rural-Urban Region (the ‘Extended PUR’), because the literature on functional relations has focused on large/global cities and urban areas/city-regions (Burger et al., 2011; Dieleman and Faludi, 1998a). The conclusions drawn from the few investigations on rural regions and rural-urban interdependencies are threefold: first, major towns within rural areas tend to account for a large proportion of commuting flows (Moss et al., 2004); second, rural-to-rural commuting is of comparable importance to rural-to-urban commuting (Harris et al., 2008); and, third, long-distance commuting among rural residents is related to the fact that rural areas often lack sufficient job opportunities (Sandow, 2008; Schindellegger and Krajasits, 1997).

Second, local and regional policies promoting polycentric urban configurations have actively attempted to develop suburban and peri-urban areas (constraining urban sprawl) to spread economic prosperity and to strengthen the territorial/economic competitiveness of all communities in the interconnected global marketplace (Brenner, 2002). These policies are elaborated in the context of cities and states that are reconfigured, re-territorialised and rescaled in conjunction with capitalist globalisation. This territorial rescaling transfers state power upwards towards supranational agencies (such as the European Union) and devolves it downwards towards regional and local levels, which are better positioned to manage urban-regional restructuring (Brenner, 1999). Moreover, the promotion of competitive relations between subnational administrative units aims to position strategically local and regional economies within supranational (European and global) circuits of capital (BRENNER, 2004). While state downscaling has been increasingly explored since the 1990s, studies have focused on socio-political aspects, and none has tackled the changing functional interactions that these reconfigured systems have caused.

Emerging from this literature review and the research gaps within debates on polycentric spatial structures, three research hypotheses underpin this study. The first hypothesis posits that the progressive extension of metropolitan influence is a driving force behind the increase in commuting in

\(^1\) According to the OECD, a ‘predominantly rural region’ is a region with more than 50% of its population residing in rural communities, and a ‘rural community’ has a population density of less than 150 persons/km\(^2\) (OECD, 2011). A distinction is also made with regard to their distance from metropolitan centres: ‘rural metro-adjacent regions’, ‘rural non-metro-adjacent regions’ and ‘rural northern regions’ (Alasia and Rothwell, 2003).
rural metro-adjacent regions, transforming them from predominantly rural regions to hybrid ones and increasing their dynamism. The second hypothesis proposes that, due to their proximity to the metropolitan centre, these rural metro-adjacent regions are gradually increasing their openness towards other regions and their integration into PUR dynamics. The third hypothesis argues that downwards transfers of state power towards the regional and local levels foster intra-regional cohesion and strengthen regional centralities.

In summary, this paper has two main contributions. First, in terms of the scale of analysis, this paper addresses the lack of understanding of mobility within rural metro-adjacent regions. Second, this paper attempts to understand the influence of two global processes, metropolitanization and state rescaling, on the commuting flows of rural regions. In other words, this paper contributes to the landscape of existing research by measuring and debating, through a diachronic functional approach, the articulation of recently rescaled rural metro-adjacent regions into PUR dynamics (and their openness to other territories) in contrast with their degree of self-containment and isolation (internal/regional cohesion).

2.3. STUDY AREA, DATA SOURCES AND METHODOLOGICAL APPROACH

2.3.1. Central Spain as a case study

The study area covers two adjacent Spanish administrative regions: Madrid and CLM (Figure 3.2.). CLM is one of only two Spanish regions that are simultaneously characterised by their rural character and by their adjacency to a metropolitan area.

Although previous studies have already assessed mobility in central Spain, most have focused on the Madrid Region (Gallo et al., 2010; García, 2010). Some scholars have analysed CLM, though in an isolated manner (Pillet et al., 2014). Only a few recent studies examine the Madrid region and the more distant provinces outside it, although none covers the entire CLM region (Solís et al., 2012, 2015). This paper contributes to the existing literature considering CLM’s intra- and supra-regional functional relations.

Since the 1980s, the Madrid region has been transformed by the consolidation of a radio-concentric transport system in the close proximity of the metropolitan centre (in addition to the traditional radial one) and the emergence of a polycentric urban structure (in contrast to the traditional monocentric model). These changes resulted in the expansion of Madrid’s metropolitan influence beyond its administrative boundaries, the peripherisation of mobility (more suburban trips), and an increasing number of interrelations with the neighbouring provinces of the adjacent CLM and Castilla y León rural regions (Solís et al., 2012).
Located between 40 km and 300 km from Madrid, CLM is a rural region with a low population density (26.4 hab/km² in 2011). Created in 1982 and comprising five provinces (Figure 3.2.) with Toledo as the new regional capital, CLM has traditionally been defined as an acephalic/leaderless region lacking functional cohesion and conspicuously influenced by Madrid (Cebrián and Cebrián, 2000). Recently, Pillet et al. (2014) analysed its polycentric urban structure and identified 10 Functional Urban Areas (FUAs) and 15 Dependent Areas (DAs) (Figure 3.2.). Each FUA comprises more than 50,000 inhabitants; the main CLM urban structure is a collection of 11 FUA centres¹, which have a large share of population (approximately 35% in contrast to the 65% of population residing in the remaining 908 CLM municipalities; see Table A.VII.1.²). However, Pillet et al. (2014) did not consider functional relations with other regions, which is an important factor influencing CLM dynamism. This paper, however, will consider supra-regional functional relations.

One of the determinants of CLM’s urban spatial configuration and dynamics has been the national ‘passing-through’ character of its transportation infrastructures. Recent investments³ have improved road and rail networks within the region, although they remain preponderantly radial⁴ with only a few tangential infrastructures (three motorway stretches and four low-frequency regional HSR connections).

### 2.3.2. Data sources

Following a functional approach⁵, the present analyses are based on origin and destination out-commuting⁶ information (inter-municipal commuting relations) included in the 1981, 2001 and 2011 Spanish censuses. These specific scenarios allow us to compare the current situation (2011⁷), on the one hand, with that of 1981 —prior to the Spanish state rescaling process (in the 1980s), Spain’s entry into the EU⁸ (in 1986) and the notorious improvement of transport systems. On the other, with that of 2001, which was the starting point of noticeable population growth (20.0% from 2001-2011 versus 7.9% from 1981-2001) and increased investments in regional transport networks under ‘national-regional’

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¹ One FUA is organized by a ‘double-headed centre’.
² Included in Appendix VII.
³ As a European ‘Objective 1’ region (OECD), CLM has received considerable European structural funds, which aim to aid in the economic and social cohesion of lagging regions by developing of transport infrastructures.
⁴ The radial high-speed rail (HSR) and motorway network connects each provincial capital with Madrid.
⁵ While morphological approaches have been used to examine polycentrism by characterizing nodes by size, spatial location, and socioeconomic features, the mere existence of nearby sub-centres does not necessarily lead to insightful functional relations among them (Lambooy, 1998). Thus, a functional approach (Limtanakool et al., 2009; Vasanen, 2012) is proposed here.
⁶ Commuting has frequently been studied to understand urban spatial structures, transportation networks and mobility patterns within metropolitan areas (Cervero and Wu, 1997; Clark and Kuipers-Linde, 1994; Sick and Harder, 2008) because it provides information on daily/recurrent travel patterns. Data availability for other travel purposes is normally very scarce, even more so in rural areas.
⁷ No more updated commuting information is available for CLM.
⁸ After the European Structural Funds Reform (1988), CLM benefited from the European funds set aside for transport investments to promote cohesion. After this reform, European ‘Objective 1’ regions, in FPS terms, experienced higher growth from 1981-2001 than other parts of the EU (EC,2004-6).
rationales, with special attention to the HSR (three of the four lines passing through the region were built between 2001 and 2011).

Figure 3.2. – Case study: the Castilla-La Mancha and Madrid Regions. Functional Urban Areas in Castilla-La Mancha and their Dependent Areas. Source: authors based on Pillet et al. (2014).

The 1981, 2001 and 2011 censuses asked for the municipalities of residence and work, although each one made this information publicly available in a different way. The 1981 and 2001 censuses provide out-commuting information for all municipalities, although 1981 data are only disaggregated towards municipalities with more than 10,000 inhabitants or provincial capital cities. In the 2011 census, data were only collected for a sample from each municipality, and out-commuting statistics, which are not available for the smallest municipalities¹, are only published for workplace municipal type

¹ There is no clear threshold above which data are publicly available.
of location and size (and not by specific flow destinations). While it would have been useful to assess the 1991 scenario, commuting data were not incorporated into the 1991 census for CLM.

These limitations only partially affect the following analyses because out-commuting information (distinguishing the destination municipalities) is available for the Madrid municipality and the eleven CLM FUA centres. Thus, despite inconsistencies among the three censuses, a consistent/comparative analysis is possible by focusing on these twelve centres. However, this emphasis on a specific number of cities allows us to distinguish trends (from 1981 to 2011) in the attraction/polarization capabilities of the emergent polycentric CLM urban system (FUA centres) in contrast to the traditional ones of Madrid, thus elucidating the effects that metropolitanization processes and the rescaling of states have had on rural metro-adjacent regions.

2.3.3. Methodological approach

The analysis involves four methodological steps. The first step considers the evolution of total CLM out-commuting between 1981 and 2011 for the entire region compared with its increasing working population. Changes between 2001 and 2011 (a period characterized by the conspicuous growth of the Madrid PUR) are also compared with those of other rural regions less influenced by metropolitan dynamics and those of the Madrid region. This first step determines whether regional openness and the spreading influence of metropolitan areas in adjacent reconfigured rural regions are driving forces for lower self-containment ratios and considerable mobility increases.

The second step includes a diachronic (1981, 2001, 2011) analysis to evaluate changes in the total share of out-commuting flows for different destinations. This analysis is applied to each of the eleven CLM FUA centres and to the remainder of the CLM region. Its purpose is to compare the evolving out-commuting concentration capabilities of the previously identified CLM polycentric urban area with those of the adjacent metropolitan area. Thus, to evaluate a possible reorganization of commuting patterns, out-commuting flows are compared (in percentage terms) in terms of their destinations, distinguishing between the following types of relations: a) relations with the Madrid Region (differentiating between the metropolitan centre and other Madrilenian municipalities) to assess metropolitan dynamics expansion effects; b) relations within CLM (differentiating between the regional capital city (Toledo), other FUA centres and the remainder of the CLM region) to assess the effect of new administrative boundaries and the consequent infrastructure investments and regional centralities reinforcement; and c) relations with any other Spanish region (excluding Madrid).

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1 The workplace location can be in the municipality of residence, a different municipality within the same province of residence, a different province within the same region, another region, or another country.
Although developed in parallel to the previous steps, the third step investigates the influence of the following factors\(^1\) on changes in the out-commuting patterns of the main regional urban system: a) the morphological features of FUA centres in terms of their population size\(^2\) (POP and POP\_VARIATION\_81-11); and b) the location of FUA centres, regarding the following: i) their distance from Madrid (D\_MAD), as a good proxy to assess metropolitan influence; ii) their average potential accessibility\(^3\) towards other FUA centres (FUA\_ACC), as a good proxy to assess the consolidation of regional centralities in parallel with the state rescaling; and iii) their average distance to other external urban areas\(^4\) (D\_OTHER\_UA) that are less than 200 km from a FUA centre and had more than 200,000 inhabitants in 2011. To obtain a general picture of this relationship (and its evolution over time), multiple linear regression models\(^5\) were estimated using a backward stepwise procedure with SPSS software (which helped avoid multicollinearity). Six models\(^6\) (one for each type of out-commuting destination) have been estimated for each temporal scenario (1981, 2001, 2011), as has the variation between 1981 and 2011.

Finally, this evaluation of commuting pattern reorganization (by comparing, aggregate\(\text{ly}, FUA\) centres with the remainder of CLM) is complemented by individual commuting trajectories for all regional municipalities (only possible between 1981 and 2001 due to data constraints). This combined approach allows for the reconsideration of the CLM functional urban areas delimited by Pillet et al. (2014), which excluded inter-regional functional relationships (Figure 3.2). Thus, the fourth step aims to clarify whether the identified CLM FUAs and DAs (and FUA centres and DA sub-centres) are predominantly internally or externally integrated. The prevailing relations of all CLM municipalities are thus examined (distinguishing between interactions mainly with the Madrid region, CLM or other Spanish regions). Hence, each FUA is characterized by the percentage of municipalities more integrated into the intra- or supra-regional dynamics and by the share of out-commuting in terms of the different destination types. FUAs/DAs comprised of a high proportion of municipalities with prevailing inter-regional interactions should thus be defined as dependent on those external areas and not on the CLM region. If these municipalities with prevailing inter-regional interactions do not represent a high proportion of the FUAs/DAs but constitute a continuous area comprising at least 6,000 inhabitants\(^7\), a

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1. Although other factors, such as urban form, transport service level/supply and socio-economic variables, may also influence commuting, this paper does not aim to evaluate them.

2. Although employment size was also considered as a possible explanatory variable in the beginning, regression models did not work well when it was included; consequently, it was excluded from the analyses.

3. Accessibility has been considered an explanatory variable that simultaneously considers distances to the rest of CLM FUA centres and their mass attraction (population). The following formulation has been proposed to evaluate potential accessibility: \(AP_i = \sum f_j / d_{ij}\), where \(f_j\) is the population of the destination FUA centre, and \(d_{ij}\), the Euclidean distance between FUA centres. Although both the average distance to the rest of the FUA centres and the distance to Toledo were considered as independent variables in the beginning, the regression models showed that they were not appropriate (collinearity).

4. The set of urban areas included Alicante-Elche, Granada, Málaga, Murcia, Sevilla, Valencia and Zaragoza (as delimited by the ‘Atlas Digital de las Áreas Urbanas’, available online at atlasau.fomento.gob.es).

5. Sandow and Westin (2010:440) demonstrated that a ‘multinomial logistic regression did not yield any significantly different results compared to the multiple linear regression model, but rather strengthens the importance of some factors’.

6. In multiple linear regressions, some scholars have recommended at least 10-15 observations per variable (Núñez et al., 2011). Consequently, the 11 observations per variable used in our models made feasible to assess correlations.

7. In accordance to the lowest populated DA identified by Pillet et al. (2014).
new dependent area in an external territory is delimited (defining its centre as the most populated area). Finally, dominant first-order flows for each FUA centre are identified to characterize their main interactions by applying the standardization method based on z-cores, as proposed by Hincks (2012). Moreover, FUA centres are clustered by looking at the evolution of their out-commuting flows towards Madrid Regions and to other FUA centres.

2.4. EMPIRICAL RESULTS

2.4.1. A progressively increasing regional openness

CLM out-commuting relations increased considerably over the past three decades at a nearly constant rate, from 43,050 workers in 1981 to 232,475 workers in 2011. Although they followed a similar trend as the regional working population, out-commuters clearly grew more than non-commuters (Figure 3.3.a.).

In an attempt to evaluate metropolitanization, the aforementioned trends are first compared with those of other rural regions less influenced by metropolitan areas (Figure 3.3.b.). CLM showed, on the one hand, a greater percentage of commuters in 2011 (31.6% in CLM versus 24.3% in Extremadura) and, on the other, a greater increase in out-commuting between 2001 and 2011 (34.5% in CLM versus 9.7% in Castilla y León, 14.0% in Extremadura and 16.6% in Aragón). CLM also showed a greater increase in out-commuting (34.5%) than did the Madrid region (20.2%) from 2001 to 2011.

Overall, these results indicate that CLM has undergone a profound transformation, from being a self-contained region to displaying more openness. This change mimics metropolitan patterns: in 2011, the CLM rural metro-adjacent region’s out-commuting share (31.6%) was similar to that of the Madrid region (38.9%). Therefore, the progressive extension of metropolitan areas is a driving force behind restructured rural metro-adjacent regions that have evolved towards greater work-related mobility levels and have transformed from predominantly rural territories into hybrid ones (displaying more metropolitan behaviours).

This greater openness has been particularly significant for CLM FUA centres (Table A.VII.1.): i.e., between 1981 and 2011, FUA centres increased their out-commuting flows by 641%, while non-FUA municipalities increased these flows by 395%. Given the remarkable performance of FUA centres in terms of regional commuting patterns, an in-depth investigation was conducted evaluating possible interrelations between their population size and location and their commuting spatial structures. The

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1 Once out-commuting flows are standardized using z-scores, first-order flows are those of exceptional magnitudes, that is, if their z-score is greater than 1.65, which is the critical value for a one-tailed test (p<0.05) (Hincks, 2012). Because the total out-commuting of a municipality is very small in some cases, an additional threshold of a minimum of 50 flows is proposed (Solís et al., 2012) to consider that relation as a first-order one and to avoid misleading conclusions.
regression models (Table A.VII.2.) are consistent in showing that, the distance to Madrid has a significant relationship with FUA centres’ out-commuting in each time scenario, although this influence decreases over time. Moreover, accessibility to other FUA centres was an explanatory variable for the total out-commuting flows in 1981, while population size explained these flows in 2001 and 2011. Similarly, the 1981-2011 evolution of total out-commuting is related to the distance to Madrid and population changes. The greater beta parameters obtained for population size compared with those for the distance to Madrid implies that proximity to the metropolitan centre is becoming less relevant in explaining rural metro-adjacent regions’ inter-municipal mobility levels, which notably depend on the centre’s size.

Based on these conclusions, the analysis of proximity to the adjacent metropolitan area was extended to all CLM municipalities\(^2\) (Figure 3.4.). Apart from the increasing out-commuting shares over time, inter-municipal flows are negatively related to the distance to Madrid, with the strongest effect occurring in 2001: i.e., there were greater out-commuting variations between concentric rings in 2001 (between 18% and 66%) than in 1981 (between 4% and 30%). This finding is in line with the regression model conclusions. Given the negative relationship between out-commuting and the distance to Madrid,

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1 Included in Appendix VII.

2 To avoid comparability errors due to 2011 data constraints, only 1981 and 2001 scenarios were analysed.
three distinct zones can be differentiated: a) a sharp drop up to 100 km from Madrid; b) a predominantly constant percentage between 100 and 220 km; and c) a sharp drop from 220 km onwards. Finally, Figure 3.4. shows the theorised extension of Madrid’s metropolitan influence beyond its administrative boundaries towards the CLM region. This overflow is noticeable, given the noteworthy 2001 out-commuting percentage (more than 50%) for areas up to 70-80 km from Madrid (while the Madrid region spans, on average, 48 km from the metropolitan centre).

Out-commuting data is depicted by grouping the 919 municipalities into 10 km-wide concentric rings centred on Madrid (see Figure 3.2.)


In summary, these results imply that metropolitan overflow is affecting CLM. The higher out-commuting percentages in the CLM municipalities closer to Madrid confirm that the municipalities closer to metropolitan centres exhibit greater degrees of openness and metropolitan behaviours. This observation may also be partially attributable to the ‘frontier effect’ (Iranzo and Izquierdo, 1999; Méndez, 2000), which is a differential effect on territorial dynamics (population, investment, economic activity, etc.) caused by policies and territorial features in different regions. For the ‘Objective 1’ CLM region, the allocation of European economic grants (FEDER, FSE), high-capacity infrastructure developments, increases in economic activity (mainly industrial activities) and low land prices have led to significant population increases (particularly in the municipalities closer to Madrilenian boundaries).
2.4.2. A reorganization of commuting patterns

Over the past three decades, changes in CLM commuting patterns have been characterised by a) a consolidation of regional centralities, which have reinforced their attraction capabilities and fostered internal CLM cohesion; b) a strengthening of metropolitan influence; and c) fewer interactions with other regions.

2.4.2.1. The consolidation of regional centralities

Despite increasing in absolute terms between 1981 and 2011 (from 28,666 to 145,415 flows), out-commuting relations occurring within CLM have remained largely stable in relative terms (either those originating in FUA centres or in other municipalities), fluctuating at approximately 60% (Figure 3.5.a and Table A.VII.1).

**Figure 3.5.** Towards a reorganization of CLM commuting patterns (1981-2011). **Fig.3.5.a (Above).** Evolving capabilities of Madrid, CLM and other Spanish regions. **Fig.3.5.b (Below).** Evolving capabilities of Madrid municipality and the main CLM urban centres in attracting commuting flows. Source: authors (based on 1981 and 2001 Censuses - INE).
However, the eleven FUA centres attract a greater number of flows from the other ten centres, duplicating first-order tangential relations from 4.6% in 1981 to 10.0% in 2011 (Figure 3.5.b. and Table A.VII.1.). This increase differs, on the one hand, from the steadiness of hierarchical relations (from the remaining CLM municipalities to FUA centres), which slightly decreased from 30.8% in 1981 to 29.2% in 2011 (Figure 3.5.b. and Table A.VII.1.), and, on the other, from the small decrease in the share of out-commuting directed towards the remaining CLM municipalities, either from FUA centres (non-hierarchical relations), which decreased from 58.7% in 1981 to 54.2% in 2011, or from non-FUA centres (second-order tangential relations), which decreased from 36.5% in 1981 to 32.8% in 2011.

Overall, these observations show the consolidation of CLM’s main urban structure as a set of centralities (FUA centres) that begin acquiring key roles in organizing regional commuting patterns (mainly tangential relations). The attraction role of the regional capital is very slowly becoming relevant (Figure 3.7. and Table A.VII.1.); i.e., between 1981 and 2011, commuting flows towards Toledo increased both from other CLM FUA centres (0.8% to 2.4%, although decreasing slightly from 2001-2011) and from the remaining CLM municipalities (8.1% to 9.2%).

Nevertheless, despite this emerging polycentric intra-regional spatial configuration of commuting flows, on a supra-regional scale, the metropolitan centre continues assuming a more significant centralizing role compared with the CLM FUA centres by attracting around 15% of the regional out-commuting flows, both from FUAs and the remaining CLM municipalities (Figure 3.5.b. and Table A.VII.1.).

According to the multiple linear regression models, the distance to Madrid and to other (nearby) external urban areas, as well as potential accessibility to other FUA centres, explained the abovementioned outstanding share of FUA centres’ out-commuting towards FUA centres in the three temporal scenarios (Table A.VII.2.). First, as might be expected, a greater distance from external urban areas (including Madrid) has a positive effect on ‘first-order’ tangential relations, which means that the FUA centres closer to other metropolitan areas interact more with external territories than with other regional FUA centres. In addition, accessibility to other FUA centres has a positive (although weaker) effect on the share of ‘first-order’ tangential relations. The FUA centre’s population size is a non-explanatory variable. Similar conclusions are drawn for the evolution of out-commuting towards FUA centres between 1981 and 2011.
2.4.2.2. Increasing metropolitan influence and decreasing interactions with other regions

Out-commuting flows overflowing the CLM administrative boundaries reveal two trends related to whether they are directed to the Madrid Metropolitan Area or to other Spanish administrative regions.

On the one hand, mobility data show that CLM FUA centres’ interactions with the Madrid region increased between from 20.2% in 1981 and to 31.1% in 2001, and then dropped to 28.1% in 2011, although the metropolitan centre’s capabilities in attracting flows from the main regional centralities have remained nearly stable at approximately 15% (Figure 3.5.b. and Table A.VII.1.). The remaining CLM municipalities’ interactions with the entire Madrilenian region gradually increased from 20.6% in 1981 to 33.7% in 2011 (Figure 3.5.a. and Table A.VII.1.). Nevertheless, the metropolitan centre’s influence increased from 16.3% in 1981 to 21.4% in 2001 but then significantly decreased to 15.5% in 2011 (Figure 3.5.b.), transferring this difference to other Madrid region sub-centres (Table A.VII.1.).

In summary, due to metropolitanization processes, rural metro-adjacent regions are increasingly becoming more integrated into metropolitan dynamics (with no apparent difference between the main urban centres and the remaining regional municipalities). Although one may think that the polarization effects of the metropolitan centre (in contrast to other Madrilenian territories) may be reinforced at increasing distances, in accordance with previous literature (García, 2010; Solís et al., 2012), the data revealed that the metropolitan influence on rural metro-adjacent regions is no longer solely exerted by the metropolitan centre; it is also exerted by other metropolitan sub-centres, which results in a polycentric spatial organization of flows on a supra-regional scale.

According to the multiple linear regression models, in the three temporal scenarios, proximity to Madrid has a clear and strong positive relationship with the share of FUA centres’ out-commuting directed towards both the Madrid region and the metropolitan centre (Table A.VII.2.). The models also show that the distance-to-Madrid effect became more relevant over time. Moreover, in 1981 and 2001, accessibility to other FUA centres was an explanatory variable for out-commuting towards both the Madrid Region and the metropolitan centre (although less significant than the distance to Madrid and with weaker effects in 2001). In this case, being more capable of accessing other FUA centres has a negative effect on the number of flows directed towards the metropolitan area. The FUA centres closer to other metropolitan areas would thus interact more with external territories than with other regional FUA centres. In 2011, the population of the FUA centre was positively interrelated with out-commuting towards the Madrid municipality, as larger centres could send higher shares of their working populations to the metropolitan centre.
On the other hand, in relative terms, commuting towards other regions has decreased by approximately half over the past three decades (Figure 3.5.a. and Table A.VII.1.). Although the percentage of CLM FUA centres’ inter-regional out-commuting was similar to that of flows towards the Madrid region in 1981, its reduction from 16.5% in 1981 to 7.8% in 2011 illustrates the difference between the two types of functional relations. The remaining CLM municipalities have also shown reductions in out-commuting flows towards other regions from 12.1% in 1981 to 4.2% in 2011, illustrating the more prominent effect of the Madrid region (Figure 3.5.a.).

For the three temporal scenarios (1981, 2001 and 2011), the distance to Madrid explained FUA centres’ inter-regional out-commuting (towards other regions different to the Madrilenian one) and as it might be expected, being more distant from the metropolis has a positive effect on the functional relations between FUA centres (Table A.VII.2.). Multiple linear regression models also show that the distance-to-Madrid effect became less relevant over time. Moreover, in 1981, the distance to other urban areas was an explanatory variable for inter-regional out-commuting (with a higher influence on the dependent variable than the distance to Madrid). In 2001 and 2011, inter-regional out-commuting was positively related with FUA centre’s size; residents in the more populated centres were more able to commute to other urban areas.

2.5. RE-DELINEATING CLM FUNCTIONAL URBAN AREAS

Out-commuting for each CLM municipality in 1981 and 2001 reveals that a significant number of them (51.1% in 1981 and 79.2% in 2001) exhibited a prevailing functional relation within CLM. Moreover, the share of municipalities for which the most weighted functional relation was directed towards CLM FUA centres grew considerably, from 18.8% in 1981 to 43.5% in 2001. This observation illustrates the aforementioned consolidation of regional centralities in 2001.

Nonetheless, the number of municipalities exhibiting prevailing interactions with the Madrid region was significant in 1981 (14.2%) and 2001 (17.4%), with the metropolitan centre exerting a predominant role (11.6% and 12.8% of CLM municipalities mainly interacted with the Madrid municipality in 1981 and in 2001, respectively). This increasing regional out-commuting directed towards the Madrid region (in both strength and extension) shows that a metropolitan-scale shift is occurring beyond the boundaries of the Madrid administrative region (Solís et al., 2012):

a) the CLM area strongly influenced by the Madrid region tripled in size between 1981 and 2001 (from 3.2% to 10.1% of the CLM municipalities), although the average distance remained stable at approximately 80 km (Figure 3.6.).

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1 Out-commuting over 50 flows (Solís et al., 2012) and representing 30% of the working population.
b) the CLM area highly dependent on the Madrid region doubled in size between 1981 and 2001 (from 2.1% to 5.0% of CLM municipalities), although the distance to the limits of the Madrid region decreased (from an average distance of 79 km in 1981 to 65 km in 2001) (Figure 3.6.).

(*) Out-commuting over 50 flows (Solís et al., 2012) and representing the 30% of the working population;  
(**) Out-commuting over 50 flows (Solís et al., 2012) and representing the 50% of the working population;

Figure 3.6. – Castilla-La Mancha municipalities strongly influenced and highly dependent on Madrid Region. Years 1981 and 2001. Source: authors.

As the number of municipalities that frequently interacted with the municipality of Madrid remained constant between 1981 (1.2%) and 2001 (1.3%), other metropolitan sub-centres are also affecting CLM commuting patterns, despite the central core playing an important role. The weight of the metropolitan centre becomes clear because the municipalities highly dependent on it are distributed over greater average distances from Madrid (93 km in 1981 and 103 km in 2001).

Conversely, the number of municipalities demonstrating prevailing functional relations with other Spanish regions (excluding Madrid) decreased from 8.6% in 1981 to 2.9% in 2001.

In summary, the aforementioned progressively increasing influence of the Madrid PUR and the diminishing influence of other regions on CLM (despite the important share of municipalities with prevailing functional relations within the region) make it necessary to reconsider the delimitation of CLM functional urban areas, as proposed by Pillet et al. (2014), which did not consider these relevant...
external relations. Particularly, out-commuting data indicates (Table A.VII.3.) that a) the ‘FUAs’ or ‘DAs’, as defined by Pillet et al. (2014), located close to the Madrid administrative region are in fact dependent on the metropolitan region; b) territories positioned close to the external administrative boundary of CLM show prevailing inter-regional interactions and should be re-delimited as ‘DAs’ of other external urban areas; and c) certain areas must be understood to exhibit both internal (CLM) and external (Madrid or other regions) relations/dependencies. Therefore, this paper proposes a revised version of Pillet et al.’s (2014) CLM functional areas (as depicted in Figure 3.7.).

Finally, the 11 regional FUA centres can be classified into five types based on their evolving (1981-2011) functional relations with Madrid and with other FUA centres (less attention is given to their relations with the entire region and with other regions because, in general terms, all the centres follow similar trends) (Figure 3.7.c).

**A. TYPE I. FUA centres highly integrated into the Madrid region**

This type includes centres that maintained relations from 1981 to 2011 almost exclusively with Madrid (over 30% in 2011). They are more integrated into Madrid's urban dynamics than into the CLM region due to their proximity to the Madrid region. These centres benefit from being located in an 'Objective 1' Region and close to a metropolitan centre (the 'frontier effect'). In 2011, these centres' first-order out-commuting flows were directed towards Madrid and other Madrilenian sub-centres (Figure 3.7.b.).

**B. TYPE II. FUA centres strongly related to both Madrid and CLM regions**

This type includes FUA centres that exhibit strong (approximately 30% in 2011) and growing relations with the Madrid region, which is substantially greater than their relations with other regional FUA centres. Strong relations with Madrid (although weaker than in Type I) result from these centres’ physical closeness to the metropolitan centre. In 2011, these centres' first-order out-commuting flows were directed towards Madrid and towards a few other close regional centres (Figure 3.7.b.).

**C. TYPE III. FUA centres weakly, although increasingly, related to the Madrid region and increasingly integrated into the CLM region**

This type accounts for centres that exhibit weak (although gradually increasing) relations with Madrid and a general increase in their relations with other CLM FUA. These centres are further away from Madrid and closer to each other across a multicentre territory. Nevertheless, in 2011, all centres had first-order out-commuting flows directed towards the Madrid municipality and towards other regional centres (Figure 3.7.b.).
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Figure 3.7. – Re-delineated CLM Functional Urban Areas. Source: authors.

Fig. 3.7.a. – Prevailing out-commuting relation for Castilla-La Mancha municipalities. Year 2001. Source: Authors.

Fig. 3.7.b. – Redefined CLM Functional Urban Areas. Year 2001. Source: Authors.

Fig. 3.7.c. – FUAs’ centres’ typology (in regards to their 1981-2011 evolving out-commuting relationships towards Madrid region and other CLM FUAs’ centres). Source: Authors.
D. TYPE IV: FUA centres progressively more integrated into the CLM region

The only FUA centre that shows declining relations with Madrid (by nearly two-thirds) has become more interrelated with other regional FUA centres and is centrally located within CLM. Nonetheless, in 2011, this FUA centre had a first-order flow towards Madrid (Figure 3.7.b.).

E. TYPE V: FUA centres poorly integrated into the Madrid and CLM regions

This type accounts for centres that exhibit weak and diminishing relations with Madrid and weak but increasing relations with other FUA centres. These centres are the most isolated and distant centres and the most loosely related to Madrilenian and CLM dynamics. In 2011, the closest centre from Madrid had a first-order out-commuting flow towards Madrid, a Mediterranean metropolitan area and other nearby DA sub-centres. The furthest centre from Madrid had only a first-order out-commuting flow towards the regional capital (Figure 3.7.b.).

2.6. CONCLUSIONS

This paper complements the scarce literature on mobility patterns of rural regions that are highly influenced by metropolitan dynamics. Changes within the CLM region, resulting from the expanding influence of the Madrid PUR and from the supposedly increased importance of regional centralities derived from the Spanish state rescaling process of the 1980s, are analysed by exploring the strength and direction of commuting patterns for three different time scenarios (1981, 2001 and 2011). Despite the specificity of this case study, this paper adds revealing conclusions that should apply to other rural metro-adjacent regions that are influenced by metropolitan polycentric regions, in which the traditional metropolis continues playing a major role, and have been recently reconfigured as administrative regions.

Due to their relative proximity to a metropolitan centre and motivated by the growth and expansion of PURs, the rural metro-adjacent regions recently reconfigured by state rescaling processes are becoming hybrid territories, exchanging their predominantly rural behaviours for more metropolitan ones. The considerable increase in their mobility levels testifies to this fact. Out-commuting is more significant in rural regions highly influenced by metropolitanization than in regions less influenced by metropolitanization, and over the past decade, this growth is even greater than that of the metro region. This observation indicates that the great transformations occurring within rural metro-adjacent regions are motivated by the growing influence of the PURs overflowing towards them. Thus, apart from the significant levels of commuting that characterize rural populations, who usually travel long distances (Sandow, 2008; Schindegger and Krajasits, 1997), this study shows the differences among rural regions’ openness in terms of their proximity to a metropolitan centre (and consequently the impacts of metropolitanization). As multiple regression models show, the closer the municipalities are to the metropolitan centre, the greater their out-commuting is. This negative effect of distance on
out-commuting has been reinforced over time; in other words, in more distant places, metropolitan effects are less significant in generating out-commuting flows, which increases differences among the areas within these rural metro-adjacent regions in terms of their closeness to the metropolitan centre. However, not only proximity to the principal city influences out-commuting levels but also population size, which has a greater effect than distance. The regression models for the regional centralities show that the larger the centre size, the greater out-commuting becomes. Because of this greater effect of population size compared with the distance to the metropolitan centre, the larger regional centralities are beginning to escape from exclusive dependency on the metropolitan centre.

Apart from influencing mobility levels, these rural regions’ closeness to a metropolitan centre results in strong interactions between the two, which reveal two distinct trends. On the one hand, their regional centralities have generally begun to reduce, in relative terms, their interactions with the PUR over the past decade, although the metropolitan centre still exerts a significant influence on most of them. As previously mentioned, these decreased interactions mean that the regional centralities have become less integrated into metropolitan dynamics and have become more integrated into regional ones. Nonetheless, differences in out-commuting relations with the metropolitan centre are also found among these centres in terms of their distances from the principal city and the remaining centralities. Being closer to the principal city and/or more distant from other regional centralities increases the number of interactions with the metropolitan centre (although the former having a greater influence than the latter). On the other hand, over the past decade, the remaining regional municipalities have become gradually more integrated into metropolitan processes and less integrated into regional centralities. Consequently, metropolitanization overflows towards adjacent rural regions occurs, mainly integrating non-centrality municipalities, while regional centralities are acquiring more competitive advantages (in relation to the metropolitan centre) and becoming more autonomous.

Second, due to the state rescaling process, these rural metro-adjacent regions are becoming internally cohesive through a set of regional centralities. This consolidation is shown by their increasing capabilities to attract out-commuting from the remaining centralities (which is in line with MOSS et al. (2004), who suggested that major towns within rural areas tend to account for a large proportion of commuting flows). As multiple regression models show, these centralities’ out-commuting directed towards the remaining centralities are positively correlated with their distances to the metropolitan centre and to other nearby urban areas and with their accessibility to other centralities. The further from the principal city or other external urban areas and/or the closer to other regional centralities, the greater the interactions within the rural region and the more polycentric the configuration of commuting patterns. Thus, the state downscaling power transfers towards the regional and local levels have helped the consolidation of regional centralities, transforming traditionally acephalic and leaderless regions into incipient polycentric ones. The fact that, 30 years after its instauration, the new rural metro-adjacent region’s capital still plays a weak, through increasing, role in attracting flows, which reinforces our conclusion about a polycentric urban structure.
In summary, a commuting reconfiguration is occurring within rural metro-adjacent regions, and multidirectional mobility patterns begin characterizing these regions, as found previously for rural districts much closer to metropolitan centres (van der Laan, 1998; Ravetz et al., 2013). The multiple interactions of rural metro-adjacent regions’ urban systems suggest that these territories interact on intra-regional and supra-regional scales. This finding leads to a methodological conclusion: an analysis of functional areas cannot be limited to administrative boundaries and must not disregard relations with other territories. Internal functional analyses (Pillet et al., 2014) suggest that regional structures are composed of functional urban areas characterized by intra-regional hierarchical relations; however, internal and external functional analyses, as proposed in this paper, suggest an intermingled network of spatial functional areas characterized by internal, external and double/combined interactions.

Finally, over the course of this study, a number of potential avenues for future research have emerged. Because less-recurrent work-related flows are becoming increasingly relevant and other socio-economic variables are significant in explaining mobility patterns (Aguilera et al., 2009), future research should explore whether rural metro-adjacent regions’ populations show peculiar behaviours related to these variables.
3. THE INFLUENCE OF EDUCATION IN RURAL METRO-ADJACENT REGIONS’ WORK-RELATED TRAVEL PATTERNS

This section presents the paper:


Abstract. Whilst contemporary functional linkages in polycentric urban configurations and their relation with the underlying settlement structure have been widely explored, little attention has been paid to their adjacent rural regions. This paper examines the spatial patterns of commuting and business travel in rural metro-adjacent regions in order to explain their reconfigured urban structure. These patterns are also compared for different working population profiles regarding their education level, to investigate how rural metro-adjacent regions offer different opportunities for average working population and other highly-skilled workers. In doing that, this work focuses on Castilla-La Mancha (Spain), a rural region under the influence of Madrid. The empirical results illustrate that regardless of education level, regional cohesion was greater for commuting than for business travel and openness to other Spanish regions was greater for business travel than commuting. They also illustrate that for highly-skilled professionals, metropolitan integration was greater for business travel than commuting while for the average working population, metropolitan integration was greater for commuting than for business travel. Nonetheless, the outstanding level of interaction within the rural region, mainly among its main urban centers, for both travel purposes, as well as the noteworthy residential concentration in those regional urban centers, suggest the emergence of an intraregional polycentric urban system.

Keywords. Commuting; Business Travel; Education; Polycentric urban structures; Rural metro-adjacent regions; Metropolitan influence; State Re-scaling.

3.1. INTRODUCTION

Whilst migration has emerged as a noteworthy issue within the social science researches (Milbourne and Kitchen, 2014), some scholars have questioned it within contemporary society, arguing that thanks to communication and transportation improvements, ‘temporary’ movements (commuting, short-term assignments, intra-company transfers, business trips or virtual contacts) have become more common and as a substitute for migration (Green et al., 1999). Consequently, a new kind of contemporary professional has emerged: the mobile professional (Kakhara and Sørensen, 2004).
In this context of increasing mobile workforce that is taking place in parallel to global economic and socio-cultural changes, monocentric metropolitan areas are becoming polycentric (Anas et al., 1998; Champion, 2001; Derudder et al., 2012; Kloosterman and Musterd, 2001; Lambregts, 2009). These polycentric urban structures have been the main focus of studies exploring the spatial organizations of functional linkages (Bell and Jayne, 2009; Criekingen et al., 2007; Florida et al., 2008; Hall and Pain, 2006). Apart from increasing mobility levels, polycentric models are happening in parallel with significant changes in travel patterns regarding destinations, times and distances (Jones, 2013; Millard-Bell and Schipper, 2011; Sassen, 1999). First, a growing complexity and dispersion in flow networks, diminishing in percentage terms travel directed to the metropolitan center (Aguiléra et al., 2009; Clark and Kuijpers-Linde, 1994; Lowe, 1998). Second, European studies have concluded that longer distances have resulted from polycentric urban models (Lyons and Chatterjee, 2008; Renkow and Hower, 2000).

Despite the fact that migration from, to and across the rural space has long represented a key research topic due to its opportunities for rural development (Bijker et al., 2015; Kilpatrick, 2011; Fratesi, 2014; Stockdale, 2006) and that some scholars have called for increased research on immobilities (Hammar and Tamas, 1997), only a few recent studies have placed more emphasis on functional linkages in rural areas located beyond the metropolitan center and its immediate surrounding territory, the so-called peri-urban area (Piorr et al., 2011; Ravetz et al., 2013). Thus, it is necessary to engage more critically with rural regions adjacent to emerging polycentric urban regions at further distances than the rural districts surrounding the principal city’s built up areas. They are an especially interesting research topic because of their increasing dynamism of past decades and since they are hybrid territories that are neither fully integrated into metropolitan dynamics nor totally rural and self-contained. In their transformation, both metropolitanization processes and the rescaling of states have been crucial.

Apart from their particular spatial coverage on urban places, debates on functional interactions have generally focused on labor commuting (Cervero, 1996; Nielsen et al., 2008). Nevertheless, in the globalization era, other types of mobility apart from commuting occupy a crucial role and constitute a key factor in planning transport infrastructures. Thus, in-depth explorations of the spatial organization of other forms of work-related interactions, such as business flows, in comparison with the commuting one are necessary. Moreover, even when taking into account a single type of flow, the spatial interaction patterns may vary regarding differences among people and firms. If these ‘multiplexity’ (different travel purposes) and ‘individual-level heterogeneity’ (different socio-economic profiles) are not considered, the analyses of functional interactions may be biased (Burger et al., 2014).

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1 Within the limits of this paper a conceptual distinction is made between the terms of ‘area’ and ‘region’, applying the second one to Administrative Regions, that is to say, to territorial units (with definitely marked boundaries) which a country is divided in.
Bearing in mind that functional interactions in restructured rural administrative regions adjacent to emerging polycentric urban regions (what we call ‘rural metro-adjacent regions’\(^1\)) have remained underexposed in literature to some extent, the aim of this article is twofold. First, to understand the spatial organizations of commuting and business travel in relation to the underlying urban configurations. Second, to explore the influence of education level and occupation on the aforementioned work-related relationships. In doing so, this research focuses on central Spain, specifically on the recently created Castilla-La Mancha (hereinafter CLM) administrative region (adjacent to the Madrilenian one), towards which metropolitan processes have already begun to have a spillover effect (Burns et al., 2009; Mendez and Rodriguez, 2007; Valenzuela, 2011). Commuting and business travel collected from two original mobility surveys provided the data to support this research: the first one addressed to a sample of regional households and the second one to three university graduate professionals (Architects, Civil Engineers and Lawyers).

The remainder of this paper is organized into the following five sections: a) a literature review on functional relationships analyses and research questions; b) the case study; c) data sources and methodological approach; d) a discussion of the evolving out-commuting patterns for the CLM region; e) a summary/debate of the conclusions.

### 3.2. LITERATURE REVIEW

#### 3.2.1. The need to explore rural metro-adjacent regions’ work-related travel patterns

The concern for disentangling the complex relationship between urban structure and mobility patterns has significantly increased since the 1970’s and 1980’s due to the emergence of polycentric urban configurations, which are characterized by externalities no longer concentrated in one city (as in the monocentric model) but shared among several interlinked intermediary centers (Derudder et al., 2012; Hall and Pain, 2006; Lambregts, 2009). More recently, improved communication and transportation systems together with the increase in multilocational firms have led to a conspicuous scale shift of metropolitan systems covering the wider context of the ‘Rural-Urban Region’ (the ‘peri-urban’ area and rural hinterland) (Figure 3.8.). This also results in the functional integration of surrounding, but historically autonomous, small/medium-sized cities (‘Historic Administrative Cities’) into the metropolitan network (Solís et al., 2015).

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\(^1\) According to the OECD, a ‘predominantly rural region’ is defined as one with more than 50% of its population residing in rural communities where a ‘rural community’ has a population density of less than 150 persons/km\(^2\) (OECD, 2011). A distinction is also made in regards to their distance from metropolitan centers: ‘rural metro-adjacent regions’, ‘rural non-metro-adjacent regions’ and ‘rural northern regions’ (Alasia and Rothwell, 2003).
As a result of these new spatial configurations, urban systems have also witnessed considerable functional transformations: multidirectional and spatially discontinuous functional relations between the metropolitan center and its wider surrounding territory and within these more distant areas have acquired more relevance, while hierarchical and unidirectional ones towards the metropolitan center have diminished in percentage terms (de Goei et al., 2010; Parr, 2005). Numerous scholars have explored if polycentric urban forms are more or less sustainable than monocentric ones by identifying changes in functional linkages, travel distances/times and modal split (Cervero and Wu, 1998; Titheridge and Hall, 2006; van der Laan, 1998). Although contradictory conclusions are found among literature, recent studies have concluded that population dispersion, economic decentralization and polycentrism have contributed to an increase in commuting distances and car-dependency (García, 2010; Schwanen et al., 2003).

Analyzing the direction of these functional relations has been identified as the most appropriate methodological approach for delineating sub-regional housing and labor markets (Burger et al., 2011; Hincks, 2012). Nevertheless, literature on functional relations has mainly focused on large/global cities and urban areas/city-regions (Burger et al., 2011; Dieleman and Faludi, 1998) paying little attention to...
rural regions. There is therefore a need for exploring rural-urban versus rural-rural functional relationships which lies in the fact that rural regions have faced multiple transformations in terms of population renaissance (Long and de Are, 1988; Renkow and Hoover, 2000), economic dynamics, regional governance and the political role of actors or the cultural dimension, increasingly blurring the traditional dichotomy between the rural (characterized with/by dispersion and backwardness) and the urban (characterized by agglomeration and advanced features) (Ortiz-Guerrero, 2013). These more entangled rural and urban identities and more elusive rural-urban distinctions have led to the conceptualization of rural regions as hybrid or networked spaces (Woods, 2009). These changes have long represented a significant research theme within rural studies and many researchers have mapped people relocation into and out of rural places (Milbourne, 2007). However, beyond this special concern on migration (Andersen, 2011; Bijker et al., 2015; Findlay et al., 2000; Findlay et al., 2001; Stockdale, 2006, 2014), there is a considerable lack of understanding about rural contemporary mobilities, which constitute an extremely interesting case study associated with increasing proportions of people deciding to remain local and traveling every day to access (more distant) opportunities (Malmberg, 1997; Milbourne and Kitchen, 2014).

Conclusions drawn from the few investigations on rural regions and rural-urban interdependencies are fourfold: first, that rural residents commute longer distances than those living in more built-up areas (Dargay and Clark, 2012; Hincks and Wong, 2010); second, that long-distance commuting among rural residents is related to rural areas’ often lacking sufficient job opportunities (Sandow, 2008; Schindegger and Krajasits, 1997); third, that major towns within rural areas tend to account for a large proportion of commuting flows (Moss et al., 2004; Sandow, 2008); and fourth, that rural-to-rural commuting is of comparable importance to rural-to-urban commuting (Harris et al., 2008).

Recently reconfigured rural metro-adjacent regions, covering a wider territory than that of the Rural-Urban Region (Figure 3.8.), towards which emerging polycentric urban regions have started spreading their influence, are a particular and extremely interesting case study. Thus, apart from the similar transformations to other rural regions, these metro-adjacent ones have been crucially affected by two set of processes. On the one hand, the growth and expansion of the traditional metropolitan areas, which are progressively overflowing towards them as one of the multiple results of metropolitanization processes. The economic growth and revitalization in the context of globalization, the new forms of rationalization of production that have resulted in economic decentralization and the consolidation of new employment centers in the metropolitan periphery, and the transport system investments (alongside the spreading usage of ICTs), are the main factors explaining the territorial transformations in metropolitan areas and the consequent mobility. On the other hand, the rescaling of states, which has led to new forms of urban governance by increasing ‘bottom-up’ strategies. This spatial and scalar reorganization equips intra-national governments (regions and municipalities) with political tools to attract external capital from global scales to improve
transport infrastructures and public facilities and to promote regional competitiveness (Brenner, 1999, 2004). It is therefore essential, first, to understand interaction capabilities (in terms of emitting or attracting flows) of these rural metro-adjacent regions and, second, to delineate dependencies with the metropolitan center or other external territories (what we call ‘openness’) or with other areas within the same rural region (what we call ‘territorial cohesion’).

3.2.2. The relevance of different travel purposes and individual socio-economic features in understanding functional linkages

From a conceptual point of view, because of the great potential variety of possible spatial interaction patterns and the different specializations of cities, the analyses of functional relationships within rural metro-adjacent regions are more demanding than when considering solely the metropolitan center and its suburban and rural hinterland (Burger et al., 2014). Hence, functional relationships analyses within rural metro-adjacent regions cannot be constrained to a single indicator and should take into account different travel purposes as well as various population subgroups.

Despite this need for taking into account different travel purposes, most studies of functional interactions have concentrated on commuting (Casado-Díaz and Coombes, 2011) and only a few have considered less frequent work-related (i.e. business trips) or non-work-related (i.e. shopping, health or leisure) travel (Frändberg and Vilhelmson, 2011; Hall and Pain, 2006; Lintanakool et al., 2007, 2009; Schwanen et al., 2001). This is so because commuting has been considered as the major daily recurrent form of travel (Hincks and Wong, 2010; Manaugh et al., 2010; Nielsen et al., 2008) and since commuting data is generally the most elaborate, reliable, and relevant interaction information available (Burger et al., 2014). Besides, commuting is one of the major forces of change in rural areas (ESPON, 2006) since, as an alternative to migration, it may give rise to the decrease of their depopulation (Sandow, 2008).

Nevertheless, even though other travel purposes different than commuting still represent a small percentage of daily travel (Aguiléra, 2008; Nelson and Niles, 2000), they have acquired a noteworthy impact on travel growth during the last decades (Ureña and Muruzábal, 2006). Particularly, business travel progressively represent an important type of mobility and an essential component of working days (Beaverstock et al., 2010; Derudder et al., 2010; Lyons, 2013; Mason, 2002; Räsänen, et al., 2010). This increased number of business relations has been evidenced in official statistics for international travel (Faulconbridge et al., 2009) but less is known about business mobility at regional and national scales (Jones, 2013). The amount, frequency and geographical patterns of business travel vary depending, on the corporation’s size, sector and internal/external organization, and on the workers’

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1 Due to the growing number of multinationals/multiplant businesses with geographically distant units/offices, the increasing intra- and inter-firm national/international relations, the improved transport infrastructures together with the relative ease of movement or the growing need to attend conferences, trade shows and courses.
socioeconomic features (gender, education level, professional status, hierarchical position, income, household structure, workplace, etc.) (Aguilera, 2008).

Therefore, since networks within extended polycentric metropolitan areas and their adjacent rural regions are multiplex phenomena and spatial interactions can vary regarding the type of functional relation considered (Burger et al., 2014), further comparative analyses on the spatial organization of commuting and business travel patterns in relation to the underlying urban system are thus needed at rural metro-adjacent regions to complement the scarce literature on this specific study area.

Moreover, as some scholars have concluded, differences in the spatial organization of functional relationships are attributable not only to the geographical mismatch between origin (home) and destination (workplace) and built-up area characteristics (density, diversity and design) (Boarnet and Sarmiento, 1998; Cervero and Kockelman, 1997; le Néchet, 2012, Sultana, 2004) but also to the workers’ socio-economic characteristics (Cristaldi, 2005; Giuliano and Gillespie, 1997; Hincks and Wong, 2010; Ma and Banister, 2007; Prashker et al., 2008; Titheridge and Hall, 2006). Despite the greater attention given to gender compared to other socio-demographic variables, variations in the number of flows and the average commuting distances were shown to be higher by occupation than by gender (Kim et al., 2012). Besides, gender together with particular occupational and employment characteristics make travel behavior patterns extremely complex (Kwan, 1999). In summary, these studies show that: a) regarding gender, women commuted shorter distances and spent less time commuting than men (Manaugh et al., 2010), which may be explained by women’s lower salaries and responsibilities of being a mother (Kim et al., 2012); b) regarding education, commuters were more highly-educated than non-commuters1 (Burger et al., 2014; Eldér, 2014; Huber, 2014; Lee and Mcdonald, 2003); c) regarding income, higher wage workers appeared to travel longer distances on average2 (Dargay and Clark, 2012; Limtanakool et al. 2006; Naess, 2006); d) for occupation, administrative and technical employees commuted longer (up to 40%) than service workers (Giuliano and Small, 1993).

Bearing in mind that both mobility levels and distances covered for reaching work and various amenities in rural or low density areas were greater than those of urban regions (Hincks and Wong, 2010; Mohíno et al., 2014) and that travel and long-distance commuting was positively correlated with education level, the extent to which these two issues have multiplying effects still remains a question.

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1 Some studies concluded that more informed household location decisions by better educated professionals would minimize commuting (Wang, 2001).

2 Increased commuting from those with higher educational levels may be justified either by higher income levels (Watts, 2009) or because search areas for jobs were larger (Garcia, 2008).
3.2.3. Research hypotheses and main contributions

Consequently, emerging from this literature review and the aforementioned research gaps, three research hypotheses drive the present study on work-related functional linkages within rural metro-adjacent regions traditionally characterized by a leaderless urban structure. The first one posits that a polycentric urban structure is emerging in these rural regions which concentrates a high percentage of working population, more relevant with increasing education, leading to a greater intra-regional cohesion in comparison with the traditional metropolitan integration. The second one proposes that highly-skilled professionals living in these regions engage less in commuting than the average working population although, on average, they are more willing to travel further distances. Conversely, the third hypothesis sets that highly-skilled professionals are more willing to engage in business travel and undertake longer distances for this travel purpose than the average working population.

Overall, the above literature review shows that mobility represents a significant theme in rural studies, although it has largely been approached restricting coverage to migratory flows. In that sense, two are the main contributions of this paper. The first one in regards to the scale of analysis, by providing a more critical understanding of contemporary/short-term mobilities in rural metro-adjacent regions. The second one in regards to the spatial organization of work-related functional linkages and how they explain these rural metro-adjacent regions’ underlying emerging urban structure influenced by metropolitanization and state rescaling.

3.3. CENTRAL SPAIN AS A CASE STUDY

In Spain, the reconfiguration of political administration and the creation of the Autonomous Communities/Administrative Regions that took place during the 1980s have been crucial in fostering rural differentiation. This study covers two of those Spanish administrative regions (Figure 3.9.): the Castilla-La Mancha (CLM) rural region adjacent to the Madrid metropolitan one, created in 1982 and 1984 respectively. The relevance of focusing on CLM lies in the fact that it is one of the only two Spanish regions that are simultaneously characterized by their rural character and by their adjacency to a metropolitan area. While scholars have already analyzed mobility in central Spain, most of them have focused on the Madrid Region (Gallo et al., 2010; García, 2010). Only a few recent works examine the Madrid region and more distant provinces outside it, although none covers the entire CLM region (Solís et al., 2012, 2015). Those studies analyzing the whole CLM region do that in an isolated manner (Pillet et al., 2014).

CLM, located between 40 km and 300 km from the municipality of Madrid, is a European ‘Objective 1’ region (OECD), with low population density (26.4 inhab/km² in 2012) that predominantly comprises municipalities of less than 2,000 inhabitants (78.8% in 2012). However, half of the population (55.6% in 2012) is concentrated in 39 municipalities with more than 10,000 inhabitants. Only seven
municipalities are between 50,000 and 175,000 inhabitants: the five provincial capitals, Talavera de la Reina and Puertollano (see Figure 3.9.).

Divided into five provinces with Toledo as its regional capital (see Figure 3.9.), CLM has traditionally been defined as a disorganized, acephalic/leaderless region that lacks functional cohesion and that is conspicuously functionally dependent on Madrid and other Mediterranean urban areas (Cebrían and Cebrían, 2000; Prada and Méndez, 2010). One of the determinants of the CLM urban spatial configuration and dynamics has been the national ‘passing-through’ character of its transportation infrastructures. Recent investments under the ‘national-regional’ rationale established after state rescaling have improved road and rail networks within the region, although they remain preponderantly radial (all its provincial capitals connected to Madrid by motorway and HSR) with only a few intra-regional tangential infrastructures (three motorway stretches and four low-frequency regional HSR connections).

NOTE. The numbers refer to the municipalities where the household mobility surveys were addressed (in bold, the eleven FUA centers identified by Pillet et al., 2014): (1) Guadalajara; (2) Toledo; (3) Cuenca; (4) Ciudad Real; (5) Albacete; (6) Talavera de la Reina; (7) Puertollano; (8) Sigüenza; (9) El Casar; (10) Azuqueca de Henares; (11) Illescas; (12) Torrijos; (13) Ocaña; (14) Tarancón; (15) Madridejos; (16) Mota del Cuervo; (17) Motilla del Palancar; (18) Alcázar de San Juan; (19) Tomelloso; (20) Villarrobledo; (21) Valdepeñas; (22) Almansa. Conversely, the surveys addressed to the highly-skilled professionals were emailed to all the members of each professional association.

Figure 3.9. -The Castilla-La Mancha Administrative region as case study: main urban (municipalities over 20,000 inhab.) and transport networks. Source: CNIG, INE, authors.

As a European ‘Objective 1’ region (OECD), CLM has received considerable European Structural Funds which aim to attain economic and social cohesion of lagging regions by, among others, the development of transport infrastructures.
Despite this CLM urban structure, not relevant in terms of population size and irregularly distributed throughout the regional territory, since the 1980s, due to the administrative decentralization led by the state rescaling, the region witnessed a considerable population growth and a centralization process towards the five capital cities (motivated by the location of public and administrative services at them as a result of the rescaling of Spain). Recent studies have accounted for an incipient CLM polycentric urban structure: i.e. Pillet et al. (2014) identified 10 Functional Urban Areas (FUAs), organized by 11 FUA centers which constitute the main CLM urban structure, and another 15 Dependent Areas on the 10 FUAs.

Not only CLM population but also its mobility patterns have changed over the last three decades (INE, 1981; 2011), characterized by: a) an outstanding increase in out-commuting, from 9.7% in 1981 to 31.6% in 2011, larger than other rural regions less influenced by metropolitan processes; b) an increase in commuting with the Madrid administrative region, from 20.5% in 1981 to 32.3% in 2011; and c) an intensified intra-regional cohesion derived from increasing out-commuting among FUA centers, from 4.6% in 1981 to 10.0% in 2011.

In the Madrid Region, transport investments since the 1980s have been transforming the traditional radial transport network in the surroundings of Madrid metropolitan center into a radio-concentric one. In parallel, processes of population/economic decentralization are leading to the emergence of new sub-centers and the integration of historic cities into the expanding metropolitan area extending beyond the Madrid Administrative Region (Solís et al., 2012). As a result, functional interrelations have developed from/towards the neighboring provinces of two different rural metro-adjacent regions (Solís et al., 2015): CLM and Castilla y León.

As a consequence of the aforementioned transport and urban networks transformations, apart from the overall increase in mobility between 1981 and 2011 within the Madrid Region (INE, 1981; 2011), from 299,668 to 1,297,709 home-to-work trips, commuting patterns have been reorganized: a) centripetal flows towards the municipality of Madrid substantially declined from 65.6% in 1981 to 44.2% in 2011; b) centrifugal flows from the municipality of Madrid to the rest of the Madrid region increased from 14.1% in 1981 to 18.5% in 2011; c) tangential (or periphery-periphery) flows between metropolitan sub-centers increased considerably from 20.3% in 1981 to 37.3% in 2011.

3.4. Data sources and methodological approach

3.4.1. Sampling and data collection

Due to the rapid development of information and communication technologies, more flexible forms of work are leading to growing diversification and complexity of workplaces (Helminen and Ristimäki, 2007; Hermelin and Trygg, 2012; Felstead et al., 2005). Therefore, it is of special relevance to distinguish
between different types of work-related mobility. On the one hand, commuting travel which comprises daily travel between the place of residence and place of work (this paper considers only out-commuters, that is, workers traveling daily for working purposes to a different municipality than that of residence). On the other, business travel which comprises work-related trips to an irregular place of work (this paper considers only business trips to a municipality other than the place of residence). However, one challenge faced by this research was, apart from the poor quality of official commuting CLM statistics\(^1\), the lack of official CLM statistics for travel purposes other than commuting, particularly business trips. Thus, data were based on two original surveys:

A. A mailed paper-and-pencil survey of school-aged CLM households

Due to the extension and population of CLM (79,463 km\(^2\) and 2,121,888 inhab. in 2012), surveying all the regional households was rejected due to human and economic resource limitations. Alternatively, questionnaires were addressed to a sample of regional households\(^2\). The methodology, previously shown to have revealing conclusions regarding mobility patterns (Garmendia et al., 2011a), consisted of organizing a tree-shape distribution and collection method with a set of key individuals (direct contacts) who distributed the leaflets to the whole sample. Both, high-schools and respondents\(^3\) (households) from last-grade students were randomly selected from a set of twenty-two municipalities (see Figure 3.9.). These municipalities, which include the eleven FUA centers identified by Pillet et al. (2014), were selected: a) by their geographical location in order to characterize key regional municipalities homogeneously distributed throughout CLM; b) by their population size and the presence of, at least, one high-school; c) by their positive 1981-2011 demographic dynamics; d) by their intermediary role and capability for organizing/articulating adjacent territories. Despite the possible bias generated by only considering part of the regional households (school-aged), this working population sector (which in the following sections will be referred as ‘average working population’) has noteworthy mobility levels and its analysis has already produced accurate, relevant and appropriate results (Pazos, 2005; Garmendia et al., 2011b).

The questionnaire was organized in two sections. First, questions about the household and its head (place of residence, gender, age, number of children in the household, education level, occupation). Second, questions about travel to other municipalities: work-related travel (commuting and business

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\(^1\) The 2011 Spanish Census has important constraints: a) it only provides information about a sample from each municipality; b) the total number of out-commuting flows is not provided for the smallest municipalities (accounting for approximately two-thirds of the CLM municipalities) and there is no clear threshold above which data is publicly available; and c) commuting information is only published for workplace municipal type of location (distinguishing among the same municipality of residence, different municipality within the same province of residence, different province within the same region, other region, other country) and size (and not by specific flow destinations).

\(^2\) Travel behavior analyses often demand an important amount of data. Due to the huge effort dedicated to collection and investigation of data in a country-wide study, household travel survey data are most frequently used for this purpose (Dieleman et al., 2002; Giuliano and Dargay, 2006, Chen et al., 2009).

\(^3\) Establishing initially the accepted error in 1% and the confidence level in 95%, the minimum sample size for the total school-aged regional households (308,245 in 2012) was 9,314. However, since based on Garmendia (2008) the response rate was estimated around 37%, in order to obtain a representative sample, a total of 25,400 leaflets were randomly distributed to last grade students of the selected municipalities during April and May 2012. The questionnaire was closed one month after distributing the leaflets at each high-school, by which time 7,332 responses had been received (29% response rate). After a debugging process, 6,901 valid answers (27% response rate) comprised the final data. The sample had less than a 1.5% margin of error and a confidence level of 95%, constituting a representative sample of all school-aged regional households.
trips undertaken during the previous complete working week) and non-work-related travel (going shopping, hiring consultancy services, visiting health facilities, leisure) undertaken during the previous complete working week.

B. An internet based survey of different types of highly-skilled professionals residing in CLM

Most existing studies about professionals’ mobility patterns examined organizations (private or public) placing little or no emphasis on self-employers. However, during the last two decades the number of workers independent of a formal organization has considerably increased (Kakihara and Sørensen, 2004). Thus, instead of focusing on specific corporations, this survey was addressed to three professional sectors (Architects - ARCH, Civil Engineers - CE, and Lawyers - LAW, residing in CLM) in an attempt to identify differences between those with university education. These professional sectors were chosen for two reasons: a) the already assessed outstanding inter-municipal mobility levels for ARCH and Engineers in other Spanish regions (Albertos et al. 2007); and b) their different engagement with the public or private sectors (CE have a strong tie with the public sector, while the other two professions are usually related more with the private one). The questionnaire was emailed to a randomly selected sample of the CLM Architecture, Civil Engineering and Legal Professional Associations in May 2012, and the electronic application was operative for four weeks. During this month, all the selected members received three email reminders from their Professional Association. Past studies have supported data collection following similar methodologies (see Table 3.1.).

This questionnaire included questions about: a) the surveyed professionals (gender, age, municipality of residence) and the company they worked for (freelance or contractual basis, public and/or private sector, size in terms of the number of offices, location of the headquarters); b) the regular workplace municipality and the transportation mode used to access it; and c) the business travel destinations during the previous complete working week. Each relation was characterized as intra- or inter-firm, by the transportation mode used and its frequency (annual, monthly, weekly, twice or more per week). Each respondent could report up to eight different business trips.

1 Establishing the accepted error in 5% and the confidence level in 95%, the sample sizes were of 127 professionals for the ARCH sector, of 174 for the CE sector and 116 for the LAW sector.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Source</th>
<th>Study area</th>
<th>Year(s)</th>
<th>Sample size</th>
<th>Type of Data</th>
<th>Aim/Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>AGUILERA ET AL</td>
<td>Official Regional</td>
<td>Paris Region (France)</td>
<td>1983 &amp; 2001</td>
<td>23,601 persons (out of 8.8 millions inhab.) 25,656 persons (out of 9.7 millions inhab.)</td>
<td>A single weekday diary for each individual of the sample (recording length, duration and mode for each trip, including both work and non-work related)</td>
<td>The relationship between work and travel behavior of workers</td>
</tr>
<tr>
<td></td>
<td>Travel Survey</td>
<td></td>
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<td></td>
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<tr>
<td>ALEXANDER &amp; DJIST</td>
<td>Specific survey</td>
<td>Utrecht-Amersfoort-Hilversum reg. (The Netherlands)</td>
<td>2007</td>
<td>13,500 respondents in the selected neighborhoods</td>
<td>2-day activity-travel-communication diary survey</td>
<td>Professional workers’ work arrangements and their relationship with electronic communications and face-to-face contacts</td>
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<tr>
<td>ARNFALK &amp; KOGG</td>
<td>Specific survey</td>
<td>Sweden</td>
<td>2000 &amp; 2001</td>
<td>Two Swedish telecommunication companies</td>
<td>A combination of:</td>
<td>Factors influencing meeting behavior within an organization (virtual vs. face-to-face meetings)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- A web-based survey recording values, preferences, opinions, skills and attitudes of employees in relation to virtual and travel &amp; physical meetings.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>- Random interview among the employees collecting a diary of travel/virtual contacts for the two previous weeks</td>
<td></td>
</tr>
<tr>
<td>FAULCONBRIDGE &amp;</td>
<td>(Specific) Interviews</td>
<td>London and New York</td>
<td>2003 - 2004</td>
<td>25 managers of globalizing law firms with multiple overseas offices</td>
<td>Opinion/perception data (advantages and disadvantages seen by professionals when doing business with or without physical contact)</td>
<td>The role of business meetings in legal professional service firms</td>
</tr>
<tr>
<td>BEAVERSTOCK</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FAULCONBRIDGE et al.</td>
<td>(Specific) Interviews</td>
<td>Non specified</td>
<td>Non specified</td>
<td>120 professionals in advertising, architecture and legal professional service firms</td>
<td>Questions about processes of knowledge management &amp; learning, management control of global PSFs, teamwork involving individuals in spatially distributed offices, and the development of global corporate cultures</td>
<td>The role of business travel as international labor mobility in the professional service economy</td>
</tr>
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<tr>
<td>HERMELIN &amp; STRYGG</td>
<td>(Specific) Interviews</td>
<td>Stockholm (Sweden)</td>
<td>2007 &amp; 2008</td>
<td>One public-sector organization</td>
<td>Combination of semi-structured interviews conducted with six employees (who also kept time diaries) and a questionnaire survey distributed to 23 employees</td>
<td>The geography of paid work: the spatiality of knowledge work and factors influencing its patterns</td>
</tr>
<tr>
<td></td>
<td>Interviews &amp;</td>
<td></td>
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<tr>
<td></td>
<td>questionnaires</td>
<td></td>
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</tr>
<tr>
<td>KAKIHARA &amp; SØRENSEN</td>
<td>(Specific) Interviews</td>
<td>Tokyo (Japan)</td>
<td>2002</td>
<td>62 mobile professionals (consultants, entrepreneurs, planners, designers, journalists, architects, freelance producers etc.)</td>
<td>Opinion/perception data (advantages and disadvantages of ICT)</td>
<td>The mobile professionals, and their use of ICTs in their everyday work practices</td>
</tr>
<tr>
<td></td>
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<td></td>
</tr>
<tr>
<td>LENZ &amp; NOBIS</td>
<td>DLR-Institute of</td>
<td>Germany</td>
<td>2003</td>
<td>3,500 German-speaking residents</td>
<td>1-day diary accounting for different travel purposes; commuting, shopping and leisure</td>
<td>People’s activity, communication and mobility patterns</td>
</tr>
<tr>
<td></td>
<td>Transport Research</td>
<td></td>
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<tr>
<td></td>
<td>dataset</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>PAZY et al (1995)</td>
<td>(Specific) questionnaires</td>
<td>Tel-Aviv metropolitan area</td>
<td>1991</td>
<td>162 women employed by eight private sector information processing units</td>
<td>Socio-demographic, work, travel characterization and the willingness to increase commuting distance or time</td>
<td>Women’s willingness to extend commuting trips in exchange for career gains</td>
</tr>
</tbody>
</table>

Table 3.1: Mobility studies: methodological approaches. Source: authors.
3.4.2. Collected data processing methodology

In both surveys (school-aged regional households and highly-skilled professionals), despite the fact that individuals were the sample units, their work trips were the basic unit of our analysis. A double comparison is undertaken: on the one hand, between average working population and highly-skilled professionals (all surveyed workers were weighted by the population of each professional association) and, on the other, among the three different types of highly-skilled professionals taken into account. This comparison is done by: a) assessing the level of engagement in commuting or business travel; b) the covered distances; and c) the commuting/business destinations. To determine the capabilities of the main CLM centralities (FUA centers) for attracting professionals (both frequent -residence or regular workplace locations- and sporadic -as business travel locations) in contrast to those ones of the metropolitan center (which have traditionally characterized the regional functional patterns), these work-related trips were classified according to their respective destinations: a) towards Madrid Administrative Region, distinguishing between those directed towards the metropolitan center and those oriented to the remaining region; b) towards CLM municipalities, distinguishing between those directed towards FUA centers and the rest of the CLM region; c) towards other Spanish regions (except Madrid) or countries.

Figure 3.10. – Functional coherence and urban structure based on functional linkages. Source: authors.

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1 The comparison is feasible since questions were asked in the same way in both surveys. In terms of commuting, respondents indicated their municipality of residence and municipality of work. In terms of business, respondents completed a diary with all the trips undertaken for business purposes during the previous complete working week.

2 Euclidian distance has been widely used in travel behavior analyses for two main reasons: a) its strong correlation with (real) travel distance or time along the road network; and b) the potential bias associated with using transportation modes other than the road network. Nevertheless, on the one hand, Euclidean distances are shorter than network ones (Elldér, 2014). On the other, in Spain: a) car ownership has doubled during the last three decades, from 0.28 cars/person in 1981 to 0.67 cars/person in 2011 (DGT, 2008 and 2011); b) car-dependency has increased as a result of population dispersion, economic decentralization and emerging polycentric urban structures (García, 2010); and even more relevant; c) in 2011, 72% of work-related travel used a car (INE, 2011) and according to the authors’ surveys, more than 70% of the commute and business trips were done by car. Bearing all this in mind, travel distances along the road network were assessed in this study.
The analysis of the direction of work-related trips originated in the rural metro-adjacent region (in terms of the geographical area and the number of destinations) and their relative weights allow us on the one hand, to determine the level of regional openness\textsuperscript{1} and therefore the regional functional coherence, and on the other, to characterize the regional urban structure in terms of the degree of interaction (see Figure 3.10.).

3.5. FINDINGS: A COMPARISON OF THE CLM RURAL METRO-ADJACENT REGION HOUSEHOLDS AND HIGHLY-SKILLED PROFESSIONALS

3.5.1. Residential concentration

Significant residence concentrations were found with regard to education levels and occupation. According to our own elaborated surveys, while 54\% of the average regional working population in 2012 resided in the eleven CLM FUA centers, this figure increased to 73\% for highly-skilled professionals. Although less significant, differences in residence location were also found with regard to highly-skilled professionals’ occupation: 79\% of CE resided in CLM FUA centers, compared to 74\% for LAW and 68\% for ARCH. Thus, in accordance with existing literature (Aguiléra \textit{et al.}, 2009; Russo \textit{et al.}, 2014), in rural metro-adjacent regions differences in residence location are also found when considering education levels, i.e., higher proportions of university-educated workers’ residences were concentrated in the main (central) cities. As some scholars have already pointed out, despite the possibility of decentralization offered by new technologies, this concentration of high-skilled workers in main cities (business centers) could be justified by the key importance given by these talented professionals to urban amenities and quality life or by the need for face-to-face contacts (Grimes, 2000; Storper and Venables, 2004; van Winden \textit{et al.}, 2007).

This relevant concentration of residential locations in FUA centers (either the average regional household or highly-skilled professionals) points to the consolidation of the CLM main urban structure as a set of centralities distributed across the territory.

3.5.2. Labor commuting patterns

Whilst scholars have already found that sensitivity to distance in general decreases as education level increases, this section explores the applicability of this conclusion to rural metro-adjacent regions residents. In doing that, the second step of this paper compares commuting travel patterns of average working population with those of highly-skilled professionals.

\textsuperscript{1} Regional openness relates to the extent to which the region is connected to external territories. It is defined here as the percentage of working population residing in the rural metro-adjacent region and traveling to a different region for commuting or business purposes.
3.5.2.1. Share of out-commuters

Contrary to previous literature for urban regions (see section 3.2.2), a lower percentage of highly-skilled workers than average ones commuted daily to a different municipality (i.e. while 17.4% of university-educated professionals were out-commuters, this was 26.0% for the average working population). This outcome, together with the noteworthy residential concentration of university-educated workers, indicates that large numbers of highly-skilled jobs must be concentrated in these main CLM centralities. This is in accordance with Öhman and Lindgren’s (2003) conclusion that occupations requiring higher education are mostly concentrated in large cities.

However, not only did education level have a relevant impact on out-commuting but occupation did as well. Significant differences were found among the three surveyed professions: CE were more mobile (40.6% commuted to another municipality) than ARCH and LAW (respectively, 13.4% and 16.5% were out-commuters) and the overall regional working population (26.0%). Hence, the share of ARCH and LAW out-commuters were clearly below the average working population. One interpretation of this is that Architecture and Legal labor markets may be more local and have more freelance\(^1\) work (more than 85%) in contrast to CE (21.8%). The former professionals decide to settle down in the same municipality as their firms in order to be established near potential clients (who consequently are the ones traveling to contract a service), thus minimizing their need for commuting. The Civil Engineering labor market expands to wider territories and therefore, corporations are located at a limited number of cities, ensuring important (global) accessibility levels. Another explanation may be the relevance of the public sector (see Table 3.2.) in this labor market (31.4% of CE, in contrast to 5.2% of LAW and 11.0% of ARCH, work for this sector) which concentrates its central administrations in main urban centers (provincial capitals).

<table>
<thead>
<tr>
<th>Sector</th>
<th>Public</th>
<th>Private</th>
<th>Both</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CE. (residing in CLM)</strong></td>
<td>31.4%</td>
<td>66.7%</td>
<td>1.9%</td>
</tr>
<tr>
<td><strong>LAW (residing in CLM)</strong></td>
<td>5.2%</td>
<td>80.2%</td>
<td>14.7%</td>
</tr>
<tr>
<td><strong>ARCH (residing in CLM)</strong></td>
<td>11.0%</td>
<td>76.4%</td>
<td>12.6%</td>
</tr>
</tbody>
</table>

Table 3.2. – Highly-skilled professionals employed in the private and public service sectors. Source: 2012 authors’ surveys.

\(^1\) Since there are no available data regarding CLM freelance proportions for highly-skilled professionals, these figures have been obtained from the own-elaborated survey.
3.5.2.2. Commuting distance

Despite the important residential concentration in the main CLM urban centers, its low demographic density (the lowest for all Spanish regions) resulted in long-distance commutes for the average working population (51.7 km) and more so for highly-skilled professionals (75.1 km) (see Table 3.3.).

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>Distance (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLM average working pop.</td>
<td>51.7</td>
</tr>
<tr>
<td>Highly-skilled (residing in CLM)</td>
<td>75.1</td>
</tr>
<tr>
<td>C.E. (residing in CLM)</td>
<td>102.0</td>
</tr>
<tr>
<td>LAW (residing in CLM)</td>
<td>30.7</td>
</tr>
<tr>
<td>ARCH (residing in CLM)</td>
<td>40.3</td>
</tr>
</tbody>
</table>

Table 3.3. – Average commuting distance (in km and minutes by road network) of CLM average working population and different types of highly-skilled workers. Source: 2012 authors’ surveys and GoogleMaps.

Similar to previous studies focused on urban areas, the recorded differences in mean travel distances demonstrated that university educated workers are more willing\(^2\) to overcome, on average, greater distances (see Table 3.3.). However, the economic activity sector had as well relevant influence on commuting distances: longer commutes were more attractive to CE (102.0 km) than to ARCH (40.3 km) and LAW (30.7 km). For these last two types of professionals, commuting was more local and distances were even shorter than the regional average (51.7 km). This is in accordance with Giuliano (1998) who found that self-employers had shorter commutes.

Nevertheless, apart from the average commuting distance which provides an insightful description of regional commuting patterns, it is necessary to evaluate the dispersion from the average and the number of commutes at different travel distances (see Figure 3.11.). Despite the fact that on average, commutes could be characterized as long-distance trips, Figure 3.11. clearly depicts that important proportions of commutes were short-distance: 63.5% of average working population and 68.0% of highly-skilled professionals commuted distances under the 50km threshold. Therefore, looking at the average commuting distances, university educated workers were expected to be more willing to overcome greater distances, but their cumulative distribution

---

1 Long-distance trips have been defined in literature, although without any consensus on the threshold used. Recently, Limtalanool et al. (2005) chose 50 km for the characterization of trips in regards to the travel distance. In Spain, according to the MOVILIA 2006/2007 survey 64% of work-related travel covered distances less than 50 km and only 13% are trips longer than 100 km. Thus, in this study long-distance trips are defined as those greater than 50 km (one-way).

2 Since higher education levels are generally associated with higher salaries which provide a larger incentive to accept longer commutes, in this paper it has been adopted the concept of willingness to commute instead of requirement. Nevertheless, detailed interviews will be necessary to clarify this issue.
revealed that only a limited share of them (32.0%) were involved in long-distance commutes. The aforementioned noticeable differences with regards to occupation are also depicted in the graph.

In sum, while highly-skilled workers commuted less but longer distances than the regional working population, significant differences were found among professional types. Two different patterns could be identified. On the one hand, CE commuted more and longer distances than both the average working population and the other highly-skilled professionals. On the other, ARCH and LAW commuted less and shorter distances. In other words, conversely to Sandow’s (2008) findings, private service employers (such as ARCH and LAW, see Table 3.2.) had a lower propensity to commute longer distances compared to those professionals more dependent on the public sector (CE, see Table 3.2.).

![Figure 3.11](image_url)

**Figure 3.11.** – Average working population’s and highly-skilled workers’ (ARCH, CE and LAW) commuting distances, cumulative distribution. *Source: 2012 authors’ surveys.*

### 3.5.2.3. Commuting destinations

Apart from the influence of employees’ education and occupation on travel distances, attraction capabilities should also be explored to grasp the complexity of CLM urban network (degree of interaction) and its regional openness to Madrid and other Spanish regions.

As Figure 3.12 illustrates, a significant proportion of commuting took place within CLM itself (more than 60%) regardless of education level. Nevertheless, higher rates of commuting within the regional territory were found among university graduates (84.3%) than among the average
working population (65.4%), which significantly interacted with the Madrid region (31.2%). Differences were also found regarding the capabilities of the main urban centers for attracting commuting flows. On the one hand, noteworthy concentrations of highly-skilled jobs at FUA centers may explain the outstanding percentage of university-educated professionals (50.9%) commuting towards them compared to the average working population (24.8%). On the other hand, the national capital (Madrid) exerted a greater influence on the average working population (22.6%, similar to the FUA centers), than on qualified professionals (10.4%). Hence, the attraction capabilities of FUA centers in comparison to those of the metropolitan center were more noticeable with increasing education.

In conclusion, compared to the average working population, regional highly-skilled professionals were less influenced by Madrid municipality and had greater relations with CLM FUA centers. Thus, considering the total share of commutes attracted by the main centers of the CLM urban network, it could be concluded that intra-regional commuting polycentricity is positively correlated with education.

Figure 3.12. - Commuting linkages of Castilla-La Mancha average working population and highly-skilled workers.

*Source: 2012 authors’ surveys.*
3.5.3. Business travel patterns

The third step of this paper compares the spatial organization of business travel of average working population with those of highly-skilled professionals.

3.5.3.1. Share of business travelers

As expected, being involved in business travel is positively correlated with level of education (see Figure 3.14.): while the percentage of working population undertaking business trips was only 4.0%, this figure rose up to 81.2% for highly-skilled workers. However, these figures were higher for ARCH (100.0%) and LAW (79.1%) than for CE (60.2%), which may be explained by the substantial number of freelancers among the two first and a large share of business trips concerning managers and executives compared to other categories (i.e. engineers) (Aguiléra et al., 2009).

As Jones (2013) suggested, distinguishing between internal/intra-firm and external/inter-firm corporate mobilities is important. While inter-firm business relationships were more relevant than intra-firm for the three considered highly-skilled professionals, they were significantly higher for LAW and ARCH than for CE (see Table 3.4.). One explanation for this could be the smaller size of firms in the former two professional sectors meaning that business meetings took place mainly with clients. On the contrary, bigger corporations within the CE labor market could imply greater relations with their headquarters or other subsidiaries.

<table>
<thead>
<tr>
<th>Business relation</th>
<th>Intra-firm</th>
<th>Inter-firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>C.E. (residing in CLM)</td>
<td>42.9%</td>
<td>57.1%</td>
</tr>
<tr>
<td>LAW (residing in CLM)</td>
<td>12.5%</td>
<td>87.5%</td>
</tr>
<tr>
<td>ARCH (residing in CLM)</td>
<td>17.6%</td>
<td>82.4%</td>
</tr>
</tbody>
</table>

Table 3.4. – Inter and intra-firm business relationships. Source: 2012 authors’ surveys.

3.5.3.2. Business travel distance

Although distances covered for business purposes (see Table 3.5.) were not significantly affected by university education (average business travel distances were approximately 120 km for both the overall working population and highly-skilled professionals), differences were found according to occupation: CE engaged in longer ones (192 km) than LAW (120 km) and ARCH (79 km). In other words, CE markets were geographically spread out to more distant territories compared to the other two professional sectors.
<table>
<thead>
<tr>
<th></th>
<th>Distance (km)</th>
<th>Distance (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CLM average working pop.</strong></td>
<td>126.8</td>
<td>79</td>
</tr>
<tr>
<td><strong>Highly-skilled (residing in CLM)</strong></td>
<td>120.8</td>
<td>72</td>
</tr>
<tr>
<td><strong>C.E. (residing in CLM)</strong></td>
<td>192.0</td>
<td>101</td>
</tr>
<tr>
<td><strong>LAW (residing in CLM)</strong></td>
<td>120.0</td>
<td>71</td>
</tr>
<tr>
<td><strong>ARCH (residing in CLM)</strong></td>
<td>79.0</td>
<td>57</td>
</tr>
</tbody>
</table>

Table 3.5. – Average business travel distance (in km and minutes by road network) of Castilla-La Mancha average working population and highly-skilled workers. *Source: 2012 authors’ surveys and GoogleMaps.*

Figure 3.13. depicts that business travel could also be characterized as long-distance (more than 50 km). Only 31.8% of average working population and 28.0% of highly-skilled professionals traveled business distances under the 50 km threshold. Nonetheless, in both cases, only more than 10% of business trips were over 200 km. While the graph also illustrates the similar behavior for the average working population and highly-skilled professionals, differences were identified among the later regarding the sector where professionals develop their activities: CE engaged in longer business trips than LAW and ARCH.

Figure 3.13. – Average working population’s and highly-skilled workers’ (ARCH, CE and LAW) business travel distances, cumulative distribution. *Source: 2012 authors’ surveys.*
3.5.3.3. Business destinations

A significant proportion of business travel took place within CLM and was positively influenced by education level (Figure 3.14.): higher rates of business trips within the regional territory were found among university graduates (66.8%) rather than among the average working population (56.4%). Differences were also found regarding the capabilities of the main CLM urban centers for attracting commuting flows: relevant concentrations of specialized services/activities at FUA centers may explain the outstanding percentage of university-educated professionals (41.1%) traveling for business purposes towards them compared to the average working population (29.2%). Thus, for an intra-regional scale, this greater attraction of FUA centers would mean a more polycentric spatial organization of qualified workers’ business travel. Interactions with both the Madrid region and the metropolitan center were similar, regardless of education (see Figure 3.14.). Not surprisingly in both cases, almost all business trips directed to that region were attracted by the metropolitan center (approximately 90%). This could mean a monocentric supra-regional spatial organization of business travel where the traditional center exerts a key role. Differences between the attractor roles of Madrid municipality and CLM FUA centers were greater with increasing education level: 22.1% and 29.2%, respectively for average working population and 24.1% and 41.1% respectively for highly-skilled professionals. Finally, there was a greater engagement with other Spanish regions or countries for the average working population (17.9%) than for qualified workers (6.8%).

![Figure 3.14.](source: 2012 authors' surveys)
3.6. DISCUSSION

While much has been written regarding the spatial configurations of functional linkages, two main gaps are found in the existing literature. First, most studies analyzed commuting independent of business travel behavior. Second, they mainly focused on large global cities, urban regions and international relations paying little attention to rural or sparsely populated regions. In an attempt to fill these gaps, this paper analyzes commuting and business travel spatial organizations for workers residing within a low-density rural region influenced by metropolitan processes, paying special attention to differences in workers’ education level and economic sector. This research was motivated by the increasing dynamism of these rural regions and the polycentric urban configurations that have been emerging during the last decades in the most highly urbanized parts of the world (and start to absorb medium-sized cities of nearby rural territories). The aim of this paper is to stimulate further discussion on the accuracy of different functional linkages when explaining the underlying urban network, in line with Burger et al.’s (2014) suggestions that different spatial organizations could result from the types of functional relations taken into account and the individual’s characteristics.

The first general (and predictable) conclusion extracted from the analyses is the increasing residential concentration in the main (central) cities with increasing education levels.

Not surprisingly, education level impacts as well on commuting travel behavior. However, contrary to previous literature, in rural metro-adjacent regions, a lower percentage of highly-skilled workers commute daily to a different municipality than the average working population. This lower out-commuting for highly-skilled professionals together with their significant concentration in central cities would mean that these highly-skilled workers’ preferences for residential location in rural metro-adjacent regions are strongly dependent on the features of the city/neighborhood, the amenities provided and that pollution, noise, congestion or land price issues are less relevant in these rural metro-adjacent regions than closer to the metropolitan center for these professionals.

From a methodological point of view, these two previous conclusions suggest the appropriateness of workers’ residence locations and their willingness to undertake work-related travel to examine the regional spatial organization.

But while fewer highly-skilled professionals travel daily from home to work compared to the regional working population, on average they are more willing to commute longer distances (approximately 1.5 times). The economic activity sector where qualified professionals develop their work also has a relevant influence on commuting distances: some labor markets (such as Architecture and Legal ones) have more local influence with firms located near potential clients. Nevertheless, noteworthy proportions of commutes (over a 60%) take place over short-distances (less than 50 km) regardless education.
Regarding the destination of the commuting flows, the following can be concluded:

a) an important regional cohesion (more than interactions towards other territories including the metropolitan region) which is especially significant for university graduates. In this regional cohesion, the role regional centralities play is notorious although a more noticeable intra-regional polycentrism can be concluded for university graduates than for the average working population.

b) a considerable integration in the metropolitan processes, but to a greater extent for the regional average working population. This could mean that while average regional workers employed in the metropolitan region decide to locate/maintain their residences in the rural one taking advantage of lower land/housing prices, as education level (and consequently, salary) increases, almost only those highly-skilled professionals working in the metro-adjacent region decide to locate/relocate within it. A monocentric spatial structure of commuting is observed regardless of education levels at a supra-regional scale (i.e. for CLM, the attraction of Madrid municipality represent more than 70% of the overall commuting flows from the Madrid region).

c) a low regional openness towards other national regions or international destinations.

In contrast, engagement in business travel is positively correlated with education level (i.e. for CLM, the percentage of highly-skilled workers undertaking business trips was twenty times larger than the one of the regional working population). Moreover, the share of highly-skilled workers traveling for business purposes is much greater than for commuting, and the opposite occurs for the average population. Although distances covered for business purposes are not significantly affected by education level (i.e. for CLM, average business travel distances were approximately 120 km), they are dependent on the economic activity sector.

The comparison between different types of travel and their relation with education levels reveals that business travel takes place over longer distances than commuting for all workers residing in rural metro-adjacent regions regardless of education. However, differences are higher for the average working population (i.e. for CLM, mean business travel distance was approximately 2.5 times that of commuting) than for highly-skilled professionals (i.e. for CLM, mean business travel distance was approximately 1.6 times that of commuting). Moreover, the three considered types of professionals are more willing to undertake longer trips for business purposes (i.e. for CLM while half of the commutes covered distances up to 30km, half of business travel covered distance up to 90 km, with a similar behavior for the average working population and the highly-skilled professionals). This is in accordance with Burger et al. (2014) who found a much more local geographical scope of commuting than business travel.

Regarding the destination of the business flows, it can be drawn:

a) a significant proportion of business travel takes place within rural metro-adjacent regions, and is positively influenced by education level. In this relevant regional cohesion, it is noteworthy...
the attractor role of main regional centralities (greater for highly-skilled professionals than for the average regional working population). It is remarkable that this role is greater than that exerted by the metropolitan center (more noticeable for highly-skilled than for the regional population), meaning an intra-regional polycentric spatial structure of business flows and consequently the consolidation of FUA centers as business destinations.

b) an outstanding integration in the metropolitan processes, although no influence of education levels has been observed for relationships towards the metropolitan region. Not surprisingly in both cases, most of the trips directed to this region are attracted by the metropolitan center.

c) a lower regional openness towards other national regions or international destinations, more significant for the average working population than for university graduates.

To summarize, the comparison between rural metro-adjacent regions' commuting and business travel patterns reveals that regardless of education level, regional cohesion is greater for commuting than for business travel and openness to external territories (different to the Madrilenian one) is greater for business trips than commuting. Besides, for highly-skilled professionals, the metropolitan integration is greater for business travel than commuting while for the average working population the metropolitan integration is greater for commuting than for business purposes.
PART III – DISCUSSION
Chapter 4
Conclusions and future research lines

1. INTRODUCTION

This chapter systematizes the features that are characterizing a new reading of rural metro-adjacent regions’ territorial reorganization. Despite the specificity of the case study considered for the empirical analyses, this dissertation adds revealing conclusions that should apply to other (recently reconfigured) rural metro-adjacent regions that are increasingly influenced by an Extended Polycentric Urban/Metropolitan Region in which the traditional principal city continues playing a major role. However, since the research studies a first-order metropolitan area (or as called in the European policies, a Metropolitan European Growth Area – MEGA) of a state whose urban system is very polarized on its national capital, it is necessary to be careful when applying these outcomes to other smaller metropolis and/or more balanced metro regions. Additionally some methodological considerations are presented in this chapter followed by potential/necessary lines for future exploration.

2. CONCLUDING TERRITORIAL REMARKS

In a context of globalization, in contrast to the traditional monocentric metropolitan model, an extended polycentric one is being consolidated, characterized by externalities shared among a collection of close-by and linked cities (either with or without predominance of the principal city). Thus, partially supported by transport networks improvements (especially road infrastructures), metropolitan centers are expanding their influence towards wider contexts leading to an interweaving of the metropolitan systems and their adjacent regions’ urban systems comprised by medium-sized cities not previously integrated in the metropolitan dynamics (see Figure 4.1.).

These emerging polycentric/interweaved urban systems are constituted by two sets of cities with a subcentral role (see SOLÍS, E., MOHÍNO, I. and UREÑA, J.M. (2015), “Global metropolitan-regional scale in evolution: metropolitan intermediary cities and metropolitan cities”, European Planning Studies
First, metropolitan intermediary cities, which are the top medium-sized cities and new globalization anchors. These metropolitan intermediary cities, together with the metropolises, shape an emerging global multicore network at metropolitan-regional scale. Second, metropolitan cities, which are the remaining medium-sized cities that connect goods and services between rural areas and the rest of the urban system.

Many scholars have already studied these metropolitan reorganizations and concluded that the emerging urban systems no longer meet relational hierarchical or monocentric logics but also periphery-periphery or center-periphery ones. However, one of the main limitations of these studies is that they are focused on large and global cities and their close by surrounding areas (that is, the traditional peri-urban areas). Thus, in metropolitan contexts where a noteworthy reconfiguration and expansion are taking place (resulting in the emergence of Extended Polycentric Urban Regions), in depth explorations are needed to understand their extended peri-urban areas (see Figure 4.1.). The potential for considering these extended peri-urban areas is threefold (Piorr et al., 2011): a) first, they may benefit from being located close to urban areas and labor markets; b) second, they may suffer from housing shortages, transport congestion, decline of landscape quality, etc.; and c) third, they are growing faster than urban areas and are witnessing the most dynamic changes.

Motivated by the current conspicuous economic, political, environmental and territorial transformations in urban systems, this thesis complements the aforementioned studies and contributes to understanding whether morphological and relational changes have occurred in other types of rural areas (until now limited to rural districts adjacent to the metropolitan center), particularly, in rural regions adjacent to the recently extended polycentric urban regions. However, the analysis of an urban system is a challenging task and recent studies suggest doing that by addressing simultaneously Castell’s ‘space of flows’ and ‘space of places’. Thus, bearing in mind the complex relation between urban structures, transport networks and mobility patterns, this thesis proposes a combination of accessibility and mobility approaches to assess morphological and relational changes within rural metro-adjacent regions. In particular, attention has been paid to changes in the: a) settlement structure; b) catchment areas and enhancement of externality; c) intra-regional and supra-regional interconnection/articulation levels; d) interaction capabilities; e) internal functional relations, mainly derived from the increasing interaction, in contrast to those ones with their adjacent metropolitan territories; and f) different roles centers perform resulting from proximity to the metropolitan center, distance to the remaining regional main centralities, infrastructure provision or population/employment size, etc.
Figure 4.1. - Changing interconnection and functional interaction complexity levels within rural metro-adjacent regions. Source: the author.
Whereas at first glance it could be expected that because of their traditional dependence on metropolises, rural metro-adjacent regions would have witnessed a greater anchoring with global/metropolitan dynamics (working against their internal cohesion), this dissertation concludes that the reorganization processes initiated during the 1970s and the increasing metropolitan dynamics overflow beyond the traditional administrative limits have led to a relational change not only within the traditional metropolitan areas but also within their adjacent rural regions, shaping their rural settlement systems and conforming new regional organization patterns (morphological change). These new mobility patterns are characterized by a growth in the number of flows and in the complexity of their spatial distribution (less hierarchical and more interconnected between the emerging centers of the polycentric urban system). In these significant internal transformations, the promotion of tangential transport infrastructures (internally connecting the region) in contrast to the traditional radial ones (connecting the region with the metropolitan center) have played a key role. This supports the first conceptual hypothesis that was established at the beginning of this thesis dissertation: “improvements in rural regions’ transport systems constitute a driving force of their urban spatial configuration changes, allowing greater internal interconnection levels and strengthening the emergence of a more polycentric urban structure”.

On the one hand, these transport improvements developed under ‘national-regional’ rationales have enlarged catchment areas and fostered potential interconnections not only with the metropolitan center but also among regional territories (that is to say, a greater number of opportunities are available within a certain travel time budget). This strengthened intra-regional articulation supports the change from the traditional Christaller’s hierarchical/monocentric territorial urban model (governed by a principal city) towards a multipolar one at different scales, leading to new urban (territorial restructuring) and politico-economic (state rescaling) relations. Nevertheless, in multicentric urban regions where a principal city (the metropolitan center) continues exerting a clear role, proximity to the metro-area is still a main determinant in morphological and functional configurations. In this sense, although internal interconnection capabilities have been favored within the entire rural metro-adjacent regions, differences appear in regards to distance from the metropolitan center: i.e. a similar enlargement of catchment areas (same surface/number of municipalities within the travel time budget) results in greater benefits for the closest areas to the metropolitan center because of the greater market sizes of the reachable municipalities.

On the other, regional transport improvements have strengthened internal cohesion (which means more balanced development with fewer disparities and territorial imbalances). Having taken into account the role of access to services and markets in improving territorial cohesion, the accessibility analyses developed in this dissertation provide evidence that the improved multimodal high-capacity transport network has helped to diminish regional disparities throughout rural metro-adjacent regions and consequently to improve the intra-regional cohesion (although the higher accessibility levels are still spatially clustered in a few centralities).
Moreover, motivated by their relative proximity to a metropolitan center and by the growing influence of the emerging polycentric urban regions towards them (and as well favored by improved transport infrastructures), these rural metro-adjacent regions are becoming hybrid territories, exchanging their predominantly rural behavior for more urban (even it could be said, metropolitan) one. The considerable increase in their mobility levels (having been during the past decade even greater than those of the metro region) testifies to this fact: i.e. out-commuting is more significant in rural regions highly influenced by metropolitanization than in those ones that while being also rural, are less influenced by metropolitan dynamics. Apart from this increase of ‘real’ interaction, functional linkages (commuting) patterns in rural metro-adjacent regions have been reorganized over the past three decades (see Figure 4.1.) and are characterized by: a) an internal articulation reinforcement; b) a metropolitan influence strengthening; and c) an inter-regional interactions decrease (excluding those with the adjacent metro region). This confirms the second and third conceptual hypotheses of this thesis dissertation: “the progressive extension of metropolitan influence is one of the issues behind the increase in commuting in these regions” which “are witnessing a noteworthy functional reorganization”.

As previously mentioned, the thesis concludes a new spatial configuration of rural-metro adjacent regions, characterized by a set of medium-sized and small cities that organize the entire region and function as engines of growth, partially favored by metropolitan dynamics overflows in parallel to the devolution/decentralization of regulatory tasks and national power to subnational administrative tiers (local and regional governments). This means that, as hypothesized at the beginning of the thesis, rural metro-adjacent regions are overcoming their traditional acephalic/leaderless and without functional cohesion character and are becoming a polycentric urban system. Nonetheless, this polycentric configuration is still weak and fragmented/dispersed in contrast to that concentrated in the close proximity to the metropolitan center.

This transformation of rural metro-adjacent regions’ urban systems towards more polycentric configurations is evidenced by:

a) the residence concentration at these regional centralities, which increases with education level. As scholars have already pointed out, despite the possibility of decentralization offered by new technologies, this concentration of high-skilled workers in main cities (business centers) could be justified by the importance they give to urban amenities and quality life, by the need for face-to-face contacts or by the noteworthy concentration of high-skilled jobs at these centers.

b) the increasing potential interconnections among these main regional centralities over time (see Figure 4.1.a., 4.1.b. and 4.1.c.). Nevertheless, their spatial distribution throughout a wider territory in contrast to the greater concentration of metropolitan subcenters leads to comparative lower levels of interconnection at an intra-regional scale. In conclusion, a lower polycentrism exists
between the main centers within rural metro-adjacent regions (which only starts being significant for business travel and to a lesser extent for commuting) than in metropolitan areas (which are more internally interlinked for all travel purposes). In these potential interconnections, new high-capacity infrastructures, such as the HSR, have played a key role allowing discontinuous catchment areas and opening up opportunities that before the new infrastructure were unimaginable (more outstanding for those peripheral municipalities that include the metropolitan center in their commuting/business catchment areas). Nevertheless, these HSR competitive advantages (in contrast to the road network) are only noticeable for high travel time budgets, that is, for commuting and business travel (see Figure 4.1.b. and 4.1.c.). Besides, the greatest accessibility improvements concentrate at these centers (despite the improvement of the intra-regional cohesion), which are as well performing best (over the average) in terms of their capabilities for competing for workplaces and for potential workers.

c) the strengthening of these regional centralities’ capabilities to attract out-commuting from the remaining regional centralities (first-order tangential relations) in contrast with the steadiness/decrease of hierarchical (from the remaining regional municipalities to the main centralities), non-hierarchical (from the main centralities to the remaining regional municipalities) or second-order tangential (among non-centralities) relations. This means that the regional centralities have become less integrated in metropolitan dynamics and more so into regional ones (see Figure 4.1.d. and 4.1.e.), being this level of integration positively influenced, among others, by distance to the metropolitan center, by proximity to other regional centralities and by the education level of the commuter. In terms of education influence, rural metro-adjacent regions show a more polycentric configuration for highly-skilled professionals while the average working population is more articulated with metropolitan dynamics. Consequently, the abovementioned reinforcement of rural metro-adjacent regions’ internal articulation has been fostered by these regional centralities. Nevertheless, despite this emerging polycentric intra-regional spatial configuration of commuting flows, on a supra-regional scale, the metropolitan center continues assuming a more significant centralizing role compared with the regional centralities.

In contrast to this weakening of interaction with the traditional metropolitan area over the past decade, the remaining regional municipalities (non-centralities) have become gradually more integrated into metropolitan processes. Hence, metropolitan effects overflows towards adjacent rural regions occurs, mainly integrating non-centrality municipalities, while regional centralities are acquiring more competitive advantages (in relation to the metropolitan center) and becoming more autonomous.

d) a significant proportion of business travel taking place within rural metro-adjacent regions that is attracted by these main regional centralities (increasing with education), even greater than that exerted by the metropolitan center (see Figure 4.1.f.). This means an intra-
regional polycentric spatial structure of business flows and consequently the consolidation of these centralities as business destinations.

Despite this incipient polycentric urban configuration within rural metro-adjacent regions, and in contrast to the theorized ‘death of distance’, different city-profiles can be identified among these centralities regarding their proximity to the metropolitan center. First, centralities close to the metropolitan center which are more integrated in metropolitan dynamics (apart from their highest levels of out-commuting, functional relations are almost exclusively with the metropolitan center). Besides, they have conspicuously benefited from the transport networks’ densification in the surroundings of metropolitan centers, which is evidenced by the increasing metropolitan subcenters’ facilities included in their enlarged reachable areas and by the greatest interaction capabilities and improvements during the past three decades. Second, centralities located at the most peripheral areas, which despite enlarging their catchment areas have weak and diminishing functional interactions with the metropolitan center and weak but increasing ones with the remaining centralities. They may witness accessibility improvements when connected to the HSR network. And third, those centralities located in an intermediate area within the rural metro-adjacent region, which despite enlarging their catchment areas are weakly related with the metropolitan center and increasingly interacting with the remaining ones. Although not comparable with centralities closer to the metropolitan center, they have witnessed significant accessibility improvements by road and/or HSR.

Apart from being influenced by proximity to the metropolitan center, different levels of polycentrism result in regards to:

a) the approach applied in the analyses (see Figure 4.1.). In general, a more polycentric configuration is observed for morphological approaches in contrast to functional ones, which means that although the connection is possible by the existing network, individuals’ prerequisites to conduct travel may not favor to overcome long-distances.

b) the functional linkage taken into account (see Figure 4.1.). Polycentric configurations are more noticeable for business and commuting travel purposes (with very similar configurations between these two) in contrast to access to daily services ones.

c) the socio-economic profile of travelers/workers. Rural metro-adjacent regions show a more polycentric configuration with increasing education. Nevertheless, differences in regards to education levels get reduced for business travel purposes.

Finally, whereas the competitive advantages of high-capacity networks have greatly benefited the transformation of rural metro-adjacent regions (since among others they open the region to greater labor markets, that is, to the metropolitan ones), those infrastructures connecting the region through a reduced number of nodes may not contribute to the emergence of a more polycentric urban structure since they reinforce only a very limited number of centers (those directly connected to the network). In
that sense, from a competition perspective, although thanks to these infrastructures regional workers
have greater access to big markets/firms (located in metropolitan areas or their surroundings), regional
firms (located in nodes not connected to the network) are in clear disadvantage competing with
metropolitan ones for attracting potential regional workers.

3. METHODOLOGICAL CONCLUSIONS

From a methodological point of view, the following concluding remarks have emerged from this
dissertation and which confirm the five methodological hypotheses established at the initial stages of
this research (see Chapter 1 - Section 3).

First, the hereby proposed diachronic blended morphological and relational approach has
been demonstrated to be a useful tool for planners and policymakers. This methodology enables the
characterization of urban spatial structures of new Extended Polycentric Metropolitan Areas/Urban
Regions at the supra-regional scale, with a special attention on their rural metro-adjacent regions. By
addressing the methodology for a set of time scenarios, it is possible to evaluate not only the current
situation of these regions but what is more interesting the reconfiguration they have witnessed. For
the hereby proposed case study, the selected time scenarios compare the present situation with that
previous to the Spanish state re-scaling process, the significant transformation of metropolitan contexts
(from monocentric to polycentric models), the proliferation of motorways (developed under 'national-
regional' rationales -which seek to articulate the entire regional territory and to foster intra-regional
linkages- in contrast to the previous national ones) and the construction of the HSR network. Thus, they
allow capturing the effects of metropolitan extension and state rescaling on urban configurations
and functional coherence of recently reconfigured rural metro-adjacent regions.

These morphological and functional dimensions are assessed by accessibility and mobility
analyses, thus paying attention to the two basic transport system components: the supply and demand
sides. This double approach allows extracting conclusions from the potential of the urban system and
transport network and the real performance within the rural region. The design of the methodology has
been based on an exhaustive analysis of literature about the complex interrelation between urban and
transport systems. Besides, the original one proposed at the beginning of the research has benefited
from a back-and-forth process and several improvements have been introduced based on the already
scientifically proved own studies.

As a first approximation to the research topic, Paper A.1: SOLÍS, E., MOHÍNO, I. and UREÑA, J.M.
(2015), "Global metropolitan-regional scale in evolution: metropolitan intermediary cities and
metropolitan cities", European Planning Studies 23(3):568-596 marked the starting point of the present
thesis dissertation. Initially concerned about the potential of medium-sized or secondary cities this work
proposed a characterization of the Extended Madrid Metropolitan Region under a double morphological and functional perspective. However, whereas this previous study constrained to the five adjoining provinces to the metropolitan region, the need to extend the analyses towards the entire rural metropolitan region was identified. Apart from the extension of the study area, other improvements were proposed to that initial methodological approach: a) due to the relevance of the HSR in the particular case study, to avoid inaccurate results, a multimodal road and HSR accessibility analysis was undertaken; and b) due to the need to include updated mobility data, 2011 Census commuting statistics were incorporated to the analyses. Instead of using APS to measure the intermediation role and global economy openness, the new approach proposed looking at the different mobility patterns in regards to travel purpose and education/occupation to shed light on the influence of high-level employments and the inclusion on global processes.

Regarding the accessibility methodological approach, it was first tested for territories closer to the metropolitan center and only for the road network (see Paper A.3 included in Appendix III: MARTÍNEZ, H., MOHÍNO, I., UREÑA, J.M. and SOLÍS, E. (2014), “Road accessibility and articulation of metropolitan spatial structures: the case of Madrid (Spain)”, Journal of Transport Geography 37: 61-73). Nevertheless, since some limitations were identified in this first approach and due to the need to cover wider territories further away from the metropolitan center (to understand changes in rural metro-adjacent regions accessibility patterns), this previous methodology was refined. Similarly, the mobility approach was improved during the elaboration of this thesis: while a first approach to the redistribution of work-related functional linkages was carried out based on own-elaborated mobility surveys (see Paper A.5 included in Appendix VI: MOHÍNO, I., UREÑA, J.M. and SOLÍS, E. (InPrint), “Patrones de Movilidad en Áreas Distantes de Regiones Metropolitanas Multicéntricas: Radialidad vs. Tangencialidad. El Caso de Castilla-La Mancha Respecto a la Región Metropolitana Madrileña”, Boletín de la Asociación de Geógrafos Españoles 69, pages not available yet), the publication of 2011 official statistics on commuting encouraged the authors to improve the analyses avoiding any misleading conclusion from the consideration of different sources.

Besides, each of the two steps in which the proposed methodology is divided, has its own benefits/strengths and opportunities:

a) the diachronic sequential and multimodal accessibility approach constitutes an adequate/accurate tool to understand urban structure transformations within rural regions highly influenced by metropolitan processes. Accessibility, understood as the facility of any land-use for being reached and which depends on the characteristics of the infrastructure and on the localization of economic activities, has been widely used to study the territorial effects of transport infrastructure (regional development, territorial cohesion, etc.). Based on a literature review which enabled identifying and assessing the advantages of each accessibility measure already used, a sequence of indicators was proposed to capture three urban processes: a) interconnection and extension; b) potential for interaction and cohesion; and c) specialization and city-profile among
centers. Accessibility indicators also enable evaluating infrastructure investments coherence/feasibility in promoting (internal) cohesion and competitiveness.

Whilst several previous studies have traditionally focused on the impacts of highways and more recently of high-speed rail, most of them fail in isolating the impacts of the various transport networks. This thesis shows that contradictory conclusions appear by applying this sequential accessibility approach to the ‘with’ and ‘without’ HSR current scenarios, reinforcing the need for a multimodal approach to avoid misleading outcomes. Besides, the relevance of simultaneously assessing the impacts of road and HSR networks lies in the fact that since the last ones are only accessible in very few points (HSR stations), it is necessary the existence of an alternative transport (road) network to allow access to each station.

In summary, by including on the one hand, demography and land use, and on the other, transport components, the first step of the methodology allows understanding the distribution of centers within the urban system and their potential relations.

b) the mobility approach contributes to characterizing evolving rural metro-adjacent regions' functional linkages (in relation with the underlying city network) by determining the changing emitting/attracting capabilities (in terms of strength and direction). This allows depicting urban structure reconfigurations and regional self-containment/isolation degree changes of recently rescaled rural metro-adjacent regions (internal cohesion) in contrast with the articulation into metropolitan dynamics (openness to other territories). Different degrees of morphological polycentrism can be measured by the concentration of population (in regards to education). As well, different degrees of functional polycentrism can be assessed by comparing different travel purposes (business in contrast to commuting) and different socio-economic profiles (highly-skilled professional in contrast to average working population). The opportunity of this comparison is that it allows evaluating whether for these less recurrent work-related travel and for this sector of the working population, rural metro-adjacent regions are more included on global processes.

While the reconfiguration of mobility patterns has been analyzed by looking at commuting (due to the lack of data for previous time scenarios for other travel purposes), this did not hamper extracting accurate and revealing conclusions. Undoubtedly, commuting has been central in the studies on spatial reconfiguration of labor markets, definition of functional areas, territorial organization, etc. This relevance lies in various facts: first, since they constitute the main travel purpose in daily mobility, their recurrence or the greater distances covered in contrast to other 'non-compulsory' travel purposes. Therefore, commuting perfectly reflects social (lifestyles, household structures, activities, daily areas, etc.) and territorial phenomena (functional organization of space and metropolitan/urban structures). On top, it constitutes a good indicator of territorial changes.
One last thought is raised here in regards to the availability of mobility data and the relevance of a reliable periodic data source continuing over time to allow evaluating territorial and social implications of different regional interventions. Whereas rural areas generally lacks of official statistics, especially for less recurrent travel purposes, this thesis shows the opportunities of own-elaborated mobility surveys addressed to a sample of the regional population (looking at different profiles of professionals and collecting information about different travel purposes) in assessing regional functional organizations. Since the main reason for this lack of data is probably due to economic limitations, an already planned collaboration in the short term with the Department of Statistics of the University of Cantabria will be aimed in elaborating a model to predict mobility based on the detailed data collected for a sample of the entire regional population. Thus, by producing a cluster of regional municipalities (in regards to distance to the metropolitan center, distance to other regional centralities, distance to the main transport corridor, centrality level, population and employment sizes, APS concentration, accessibility levels, HSR provision, etc.), and by addressing mobility surveys to a sample municipality of each cluster, it will be possible to predict mobility patterns of the entire regional territory. It is evident that while a comparison is not possible with past decades, it is necessary to continue developing mobility surveys such as those elaborated in this dissertation, to allow future territorial analyses.

4. FUTURE RESEARCH LINES

This section describes the interesting new research lines that have continuously appeared throughout the elaboration of this thesis (some of them already initiated).

1. The first line of future research relates to the limits of the study area. This dissertation focuses on rural regions highly influenced by the overflowing effects of their adjacent metropolitan areas, but only relations to the main/first-order national metropolitan areas are disaggregated. Nevertheless, other adjoining secondary metropolitan areas and their influence on these rural regions reorganization should be explored more in detail.

Moreover, since it has been concluded that some areas of rural metro-adjacent regions are more integrated in external territories, future research should carefully think about the appropriateness/adequacy of the administrative boundaries. In that sense, within these already adopted administrative divisions of the Spanish territory, it is still necessary to define the future potential urban models to be achieved within these regions (this is, the polycentrism fostered from the European spheres) and future rural-urban collaborations. In relation to this, from a policy perspective metropolitan transport consortiums should readapt their supply to cope with these hierarchical relations for the more recurrent travel purposes (commuting).
2. Since the projected tangential regional network at the hereby analyzed case study is very slowly being consolidated (up to now only three tangential motorway stretches are built and the HSR offers limited tangential services), in-depth analyses of the opportunities these projects (such as a new orbital road approximately 100 km from the metro-center) will open up for the regional reconfiguration towards a more polycentric urban structure need to be developed. Their aim would be to identify potential areas to promote economic growth as decentralization poles of the metropolitan area.

3. Another future research line relates with evaluating the effects of distance (to the metropolitan center) on the capabilities for interaction. It is well known that the results of the potential accessibility indicator depend on the value of the distance exponent, which represents the effect of the geographic space friction on economic flows. Whereas this thesis considered an exponent which was estimated for the Spanish road network, based on the own-elaborated regional mobility surveys, distance decay functions should be estimated for the specific case study and for each travel purpose.

4. While this thesis’ functional analyses have focused on work-related travel, other ‘non-compulsory’ (shopping or social/recreational/leisure) purposes have acquired a noteworthy impact on travel growth during the last decades. Future research should incorporate this less recurrent travel purposes to determine their spatial configurations. This future research would continue the work initiated during the first stages of the thesis that, based on an own-elaborated household survey, preliminarily analyzed commuting, business, shopping and access to health services in 2012, determining different degrees of functionally polycentrism within CLM rural region in regards to each travel purpose. The outcomes of this comparison were presented at the “9th European Urban & Regional Studies Conference – Europe and the World: Competing Visions, Changing Spaces, Flows and Politics” held at University of Sussex in July, 2013. The conference paper is included in Paper A.7. (see Appendix IX): MOHINO, I., UREÑA, J.M., SOLÍS, E. and MARTÍNEZ, H.S. (2015), “Distant areas of multicentric metropolitan regions households’ functional relationships: radial versus tangential mobility patterns”, 9th EURS Conference, University of Sussex, 10-12 July, 2013. However, the lack of official statistics for other travel purposes apart from commuting in these rural regions for the past, will constraint this analysis being impossible to develop a diachronic comparison for the entire region.

Similarly, it also seems interesting to explore the influence of other features of workers and jobs on rural mobility (such as the size of the company or the position workers occupy at them). Finally, in terms of mobility, apart from just the data obtained from travel diaries (origin-destination of flows), it would be extremely useful to characterize flows, that is to say, to interview workers/travelers to understand the motives and particular circumstances under which they
undertake specific trips (for instance, to see why workers choose long-distance commuting as a mobility strategy).

5. While the interaction/functional analyses have focused here on passenger transport, future research should pay more attention to capital, information and goods flows. For the national scale, goods transport along the road network has increased during the past years. These figures are in significant contrast with the rail ones: in 2012, 133,417 tons-km were carried along the road network while only 7,477 tons-km were moved by conventional rail. In that sense, future planners and policymakers should consider to promote the use of the existing conventional rail network for good transport instead of the development of new road stretches (in some cases duplicating existing ones). In other words, future policies should foster the already existing rail network, strengthening the traditional centrality of some regional municipalities which have suffered from a reduction in rail services or even the close of the station. This could result in the development of a two-level polycentric urban structure.

6. Because of the outstanding growth in internet use, which has led to noteworthy impacts on everyday life (including travel) and to more flexible work forms, this issue is of relevant importance to be explored in future research. Whereas much has been written on the impacts of Information and Communication Technologies (ICT) development and transport improvements on face-to-face business relations, the extent to which ICT influence work-related travel patterns in rural regions is still an issue that remains to be explored. During this thesis, a preliminary approximation to understand ICT usage and its relation with distance was developed. A comparison between physical travel and virtual contacts was carried out for one of the three professionals sectors surveyed during this research (CEs) and results are gathered in Paper A.6 (see Appendix VIII): MOHÍNO, I., UREÑA, J.M. and MARTÍNEZ, H. (2014), “Relaciones Funcionales de Profesionales Altamente Cualificados en Áreas Distantes de Regiones Urbanas Multicéntricas: El Caso de los Ingenieros de Caminos en el Contexto Madrileño”, Scripta Nova XVIII (488), available online at: http://www.ub.edu/geocrit/sn/sn-488.htm. The analyses revealed that CE physical and virtual business contacts had similar patterns and that most interactions took place within CLM territories, reinforcing pre-existing and close relations, not only new and long-distance ones. The relevant proportions of physical and virtual relationships within CLM and towards Madrilenian destinations could mean that face-to-face contacts for business purposes still hold an important function for mobile professional work.

7. Different scholars have already investigated whether the emerging metropolitan model are sustainable ones. This issue of the sustainability of urban and transport systems is still a question within rural metro-adjacent regions’. In that sense, while a preliminary comparative analysis of modal split in regards to travel purpose and education level has been already carried out for the rural metro-adjacent region of CLM and was presented at the Conference “High speed rail and the
city: tourism and dynamics around stations” held by the University of Paris-Est Marne-La-Vallée in January, 2015, more in depth analyses are needed. This conference paper is included in Paper A.8 (see Appendix X): **MOHINO, I., UREÑA, J.M., & SOLÍS, E. (In Print) “The influence of education on work-related travel in rural metro-adjacent regions: the case of Castilla-La Mancha (Spain)”, The Open Transportation Journal.**


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APPENDIX I

Paper A.1

Global Metropolitan-Regional Scale in Evolution: Metropolitan Intermediary Cities and Metropolitan Cities

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ABSTRACT The case of Madrid is used as empirical focus to propose a new classification of the metropolitan region urban medium-sized or secondary city system. Based on a methodology that integrates the morphological (size, location and socioeconomic history) and the functional dimensions (centrality index, advanced producer services (APS) concentration and commuting), the article compares new employment centres—cities with metropolitan origin—and historical cities—previously free standing cities, progressively integrated in metropolitan processes. The results show a distinction between (1) metropolitan cities, with a traditional intermediation role, and (2) metropolitan intermediary cities, that include an additional quality to their traditional intermediation role, that of concentrating APS. The article confirms that some medium-sized cities—metropolitan intermediary cities—linked to different origins and up to 100 km away from the metropolis are more visible in the global scene and are establishing an emerging global multicore-network at a metropolitan-regional scale.

1. Introduction

Metropolitan regions progressively established as basic motors of the global economy (Scott, 2001) are encouraging two related research lines: one focussed on analysing the driving forces transforming monocentric metropolitan areas into multicore metropolitan regions (Cattan, 2007; Champion, 2001; Charbonneau et al., 2003; Derudder et al., 2012; Feria & Albertos, 2010; Hall & Pain, 2006; Kloosterman & Musterd, 2001; Ureña et al., 2013) and the other focussed on developing strategies to strengthen the economic, social and environmental externalities of cities in metropolitan realms (Boix & Trullén, 2012; Cardoso & Meijers, 2013; Halbert et al., 2006; Hodos, 2011; Hoyler et al., 2008a; Otgaar et al., 2007). Scholars have already called such clusters of cities poly-
centric/polynuclear/multicore urban regions, mega-regions, global city regions or global mega-city regions to indicate that the externalities are not confined to a single urban core, but are shared among a collection of close and linked cities (Burguer & Meijers, 2012; Camagni & Salone, 1993; Capello, 2000; Luthi & Thierstein, 2009; Pain, 2012; Scott, 2011; Ureña et al., 2013).

The emerging spatial form of post-industrial urban regions (with various “cores”) is produced through four different ways:

- **Type 1.** The generation of new employment centres (NECs) or subcentres (Giuliano & Small, 1991; Marmolejo et al., 2011; Richardson, 1988).
- **Type 2.** The integration of large or big cities and their surrounding suburban hinterlands (Florida et al., 2008; Friedmann & Miller, 1965; Gottmann, 1964).
- **Type 3.** A series of cities and towns physically separated but functionally networked (Hall & Pain, 2006).
- **Type 4.** The intertwining of the metropolitan urban system and the medium-sized city system (Champion, 2001; Kunzmann, 2009; Lambregts, 2006; Solís et al., 2012).

Up to now, most scientific literature has focussed on the first three processes with little attention on the fourth (Type 4) (Cardoso & Meijers, 2013; Solís, 2012). This paper stimulates further discussion firstly on the spatial scale and degree of interaction between centres. As Lambregts explains

> polycentricism at the city-regional level not only refers to the outward diffusion from larger cities to smaller centres within their spheres of influence, but also to the kind of development in which the spheres of influence of several smaller or medium-sized cities start to interfere. (2006, pp. 116–117)

A new metropolitan scale is unfolding as a result of a progressive intertwining of the traditional metropolitan urban system and the medium-sized city system around it. Discussion is further stimulated secondly on the variety of cities and origins out of which an urban multicore configuration can emerge. Research on global city formation during the last years has pointed out that global cities consist of multiple cities and their hinterlands may themselves be subject to urbanization processes (Derudder, 2006; Pain, 2012). In spite of everything, the discussion about current spatial global challenges is mainly focussed on large capital, primate and global cities (Bell & Jayne, 2009; Cardoso & Meijers, 2013; Van Heur, 2010). Recent studies such as those of Cox (2012), ESPON-Report (2012), Hodos (2011) or OECD (2012) reveal that the economies of some medium-sized or secondary cities behave more dynamically than those of large metropolises. This has driven us to think about some research areas that should have been considered (a) comparison of medium-sized cities with different origins in extended metropolitan regions; NECs—with metropolitan origin—and historic cities—free standing cities and progressively integrated in metropolitan processes; (b) comparison of the way they fit into the conditions of extensive urbanization and increasing integration of urban territories and (c) evaluation of their recent and increasing global economy openness—through the concentration of advanced producer services (hereinafter referred to as APS).

In order to achieve this, the Madrid metropolitan region is considered as a case study. The paper is divided into four sections. The first section, describing the theoretical
framework, synthesizes the existing literature on the main factors used to establish a typology of cities that combines the morphological dimension (size, location, and origin) and the functional one (centrality and spatial organization). The second section describes the methodology, data, and sources. The third section presents the results of the Madrid case study. Finally, the fourth section summarizes the conclusions.

2. Multicore Urban Configurations: Morphology and Function Dimensions

Appropriate interpretation and classification of an urban system require considering both city attributes (space of places) and functional linkages (spaces of flows) (Camagni, 2003; Castells, 2000; Taylor, 2007). Therefore, the literature review section is structured according to the two main approaches that have been traditionally used in measuring spatial structures: morphological dimension and functional dimension.

2.1. Morphological Dimension

The morphological dimension is linked to a categorization of nodes according to their size, spatial location, and socioeconomic origin and evolution (Burguer & Meijers, 2012; ESPON, 2004). Even though several studies have explained different ways of generating multicore territorial structures (Burguer & Meijers, 2012; Champion, 2001; Ipenburg & Lambregts, 2001; Muñiz et al., 2005; Parr, 2004), the comparative analysis of eight European mega-city regions2 coordinated by Hall and Pain (2006) is one of the most stimulating. They synthesize the regional distribution of towns and cities of different sizes in each mega-city region, paying particular attention to a new urban network based on a “series of anything between 10 and 50 cities and towns” (Hall & Pain, 2006, p. 3).3 Nevertheless the threshold they considered to differentiate medium-sized cities from small ones is not clear. Applying the name medium-sized cities to Düsseldorf with over 500,000 inhabitants, Lieje with 195,000 inhabitants, Leiden with 150,000 inhabitants, Cambridge with 120,000 inhabitants and Chartres with only 40,000 inhabitants.

Although different countries use different measures to define medium-sized cities, this article uses the interval of 20,000–500,000 inhabitants based on the literature about Europe (Andrés, 2008; Antikainen & Vartiainen, 1999; ESPON, 2004, 2006, 2007; Ganau & Vilagrasa, 2003; Giffinger et al., 2007; Growe, 2012; Henderson, 1997; Henderson & Wang, 2007; Kunzmann, 2009; Rodríguez-Avial, 1989; Turok & Mykhnenko, 2007).

Moreover, a second aspect to be clarified about medium-sized cities is their origin (socioeconomic history). Up to now the relevant literature has described several partial classifications:

- Garreau (1991, p. 113) identifies the Boomers type—having developed incrementally around a shopping mall or highway interchange; the Greenfields type—having been master-planned as new towns, generally on the suburban fringe; and the Uptowns—centres built over an older city or town, sometimes as satellite cities.
- Hall and Pain (2006) differentiate between first cities, the metropolis and secondary cities. Within the latter they distinguish between small cities—present nodes resulting from the metropolis decentralization process; the new towns—present nodes resulting
from a planned regional process to decongest metropolises; and the traditional economic cities developed since the industrialization period.

- Freestone and Murphy (2007) establish a suburban office area typology composed of traditional centres (fringe Central Business District, secondary Central Business District, suburban town centre, office corridors and business zones) and new centres (regional business parks, office parks, freestanding offices, campuses and technoburbs).

- Lacour and Puissant (2008) differentiate, within metropolitan processes, the medium-sized cities and their role as “metro-centralities”. These cities were related to central powers, and they were consequently endowed during the nineteenth century with “head-down functions” (p. 7). These administrative functions were completed with medical, banking, legal and educational activities.⁴

Taking into consideration their socioeconomic evolution, medium-sized cities in metropolitan contexts can be classified according to Solís et al. (2012) as: (a) NECs, as those cores that three decades ago were satellite cities, dormitory cities, small towns or new towns; and (b) historical medium-sized cities, as those freestanding cities with administrative and/or economic roles in the national urban system since industrialization and the nation-state formation (s. XVIII–XIX) periods.

A third aspect to be clarified is the way in which the economy readjusts, which is made evident by selective and diffused decentralization and re-concentration processes. Recent studies on the relation between APS strategy location and physical distance at metropolitan scale (Doloreaux & Shearmur, 2009, 2012; Duranton & Puga, 2001; García & Muñiz, 2009; Karlsson et al., 2013; MacCann, 2007; Shearmur, 2008) conclude that (1) distance and location have not disappeared from economic life, (2) various types of spatial friction act (just as economic sectors) at different spatial scales and (3) APS are strongly clustered geographically and occurring close to the metropolitan core and, due to cost-saving process, in smaller more specialized cities.

The article shows two spatial patterns of the location of APS in medium-sized cities within metropolitan regions in the context of the transportation network and accessibility improvement: (1) proximity to the metropolis (<30 km) and a mixed tertiary and industrial or a specialized tertiary economic base promotes the concentration of APS with the population size not being a required pre-requisite; (2) at a distance between 50 and 100 km, medium-sized cities that have had a relevant politico-administrative role in territorial organization also favour the concentration of APS.

2.2. Functional Dimension

The functional polycentrism concept has been traditionally related to urban—urban functions—and to flows between cities (Burguer & Meijers, 2012; Burguer et al., 2013; Davoudi, 2003; ESPON, 2004; Green, 2007). Based on the two types of cores already identified, NECs and historical cities, this section collects what scholars have considered in defining the functional roles of each city, distinguishing centrality and spatial organization.

2.2.1. New employment centres. From the point of view of centrality, NECs have been studied in terms of rivalling the Central Business District (Anas et al., 1998; Lambregts, 2006) and synergy between firms and cities (Camagni & Salone, 1993; Meijers, 2005; Taylor, 2012a) in contexts of increased functional mix, greater qualification and concen-
tration of APS (Criekingen et al., 2007; Hoyler et al., 2008b; Luthi & Thierstein, 2009; Phelps et al., 2006).

From the metropolitan territory spatial organization point of view, NECs have been studied taking into consideration their flows attraction and their capacity to establish networks (Capello, 2000; ESPON, 2004; Lambregts, 2009; Taylor et al., 2007). Recently, a number of studies have sought to understand the influence of employment centres over metropolitan economy APS interdependencies (relationships between individual members—firms and cities—of an entire system of cities), such as APS-commuting, telecommunication traffic data, business and virtual contacts, as well as the types of relationships (asymmetrical, hierarchical, etc.) and the types of linkages (external and internal) of the metropolitan region (Cooke, 2013; Hall et al., 2006; Hoyler et al., 2008b; Luthi & Thierstein, 2009; Taylor, 2007).

2.2.2. Historical medium-sized cities. Since the 1980s, several changes have been detected in the economic base of medium-sized cities and their relations with the rest of the urban system (Camagni & Salone, 1993; Delgado, 1995; OECD, 2012). This has promoted the notion of intermediary city (Bellet & Llop, 1999; Gault, 1989). In metropolitan contexts these cities may play a double role, as: (a) a boost and interrelation centre for the rural areas (reinforcing a new town–country relation) and (b) an equilibrium centre to combat metropolitan macrocephaly and to induce polycentric urban systems (Andrés, 2008; Bellet & Llop, 1999; Calafati, 2011; CEC, 1999; ESPON, 2006; Gault, 1989; Hildreth, 2006; Kunzmann, 2009).

In relation to their urban system centrality role, historical medium-sized cities have been understood through their population (demographic weight naturally constitutes the most favoured indicator for choosing the location of certain services and facilities), transport (efficiency and accessibility of transport infrastructure), tourism (indicator of attractiveness), amenities, manufacturing, knowledge, decision-making in the private sector (capacity to influence) and decision-making in the public sector (the development of administrative functions) (Adam, 2006; Antikainen & Vartiainen, 1999; ESPON, 2004; Ganau & Vilagrasa, 2003; Growe, 2012; Henderson, 1997; Hildreth, 2007; Kunzmann, 2009; Leichenko, 2001; Méndez et al., 2008; Turok & Mykhenenko, 2007).

Overcoming this traditional understanding of medium-sized cities centrality, some authors talk about their capacity to concentrate APS in enlarged metropolitan contexts (Coffey & Shearmur, 2002; García-López & Muñiz, 2009; Halbert, 2004; Lacour & Puissant, 2008; Méndez & Sánchez Moral, 2010). Thus, there is a need to differentiate, as proposed by Halbert (2004, 2005), between the traditional classification of production, distribution or reproduction functions and regulatory functions and the intermediation functions, offering a new type of knowledge economy centrality which operates at a global scale.

In relation to their spatial organization role, historical medium-sized cities have been studied through urban–rural relationships (work, shopping, cultural activities, recreation and tourism, waste and pollution, etc.) and through their relationships with cities of a similar and larger size (Davoudi & Stead, 2002; ESPON, 2004; Lambregts, 2009; SMESTO, 2006; Solís, 2011; Ureña et al., 2012). Despite the very recent interest on APS as a sign of medium-sized cities spatial organization capabilities, there are very few studies about APS–intercity relationships (Luthi et al., 2010) and, on top, there is a lack of official statistics that allow studying them. Due to this, the present article uses information on APS employment located in each city.
3. Methodology and Case Study

The Madrilenian metropolitan region, which overflows its political regional boundaries (Feria & Albertos, 2010; Roca et al., 2012; Solís et al., 2012), penetrates into provinces of the two adjoining regions: Ávila and Segovia (Castilla and León region) and Cuenca, Guadalajara and Toledo (Castilla-La Mancha region). It is approximately a circle of 150 km radius centred in Madrid (Figure 1). In 2011, this area contained 39 medium-sized cities (nuclei of between 20,000 and 250,000 inhabitants, while the municipality of Madrid has 3.3 million inhabitants), which are studied with a double perspective: morphological and functional.

3.1. Morphological and Functional Dimensions

Taking into account the morphological dimension—size, location and socioeconomic evolution criteria—used to investigate urban structures in multicore metropolitan regions, Figure 2 presents their simultaneous integration and a classification to facilitate

![Figure 1. Study area. Source: Authors.](image-url)
comparative analyses. The socioeconomic evolution differentiates between NECs and *historical medium-sized cities*. Historical medium-sized cities with administrative and economic roles are designated historical administrative cities (HACs, hereinafter as) and those only with an economic role are designated historical economic cities (HECs, hereinafter as).

Regarding the functional dimension, the objective is to overcome the traditional view of centrality and spatial organization by including the role of APS. Due to the important role of APS in the local, metropolitan, and, more so, global economy and territory, this article proposes a new framework to classify the centrality and the spatial articulation capacities of cities in metropolitan contexts (Figure 3). This includes two defining concepts: (a) *metropolitan cities* to describe those cores that house centrality levels according to traditional functions (administration, transport, tourism, etc.) and population attraction capacities (for purposes of work, leisure, consumption, etc.); and (b) *intermediary metropolitan cities* to identify globalizing anchors, those cores that on top of having traditional centrality levels also have a high concentration of APS, thus possessing important flow interrelation capacity over the knowledge economy (Figures 3 and 5).

**Figure 2.** Variety of cities regarding their origin.
*Source: Authors.*
3.2. The Emergence of a New Type of Multicore Urban Regions

Before exploring the morphological dimension—size, location and socioeconomic history—and the functional dimension—types of city level functions and types of relations between them and at different scales—and based on the work by Champion (2001) on the multicore emergence followed paths, this article proposes a blended path (Figure 4).

This blended path integrates the three types of functional integrated space described by Champion (2001, pp. 665–664): (a) the centrifugal path, from monocentric to polycentric region that derives from outward diffusion from the metropolis over small towns and/or satellite cities—in Madrid, this process started during the 1980s and became stronger during the 1990s (Gutiérrez, 1992; Solís, 2011); (b) the incorporation path, from a large urban centre expanding its urban field so that it incorporates centres in the surrounding area that had previously been largely self-sufficient in terms of both employment and services—in Madrid this process starts during the 1990s and gets stronger during the first decade of the twenty-first century (Solís, 2011; Solís et al., 2012) and (c) the fusion path, from the fusion of several previously independent centres of similar size as a result of their own separate growth both in overall size and lateral extent, and particularly because of the improvement of transport links between them—in Madrid this process has slowly started during the last decade (Solís, 2011; Solís et al., 2012). In addition, these fusion processes take place over a grid of nodes composed by metropolitan intermediary cities connected in global economy circuits and also in metropolitan economy ones.
Figure 5 specifies the data, variables and sources used to analyse the Madrilenian urban system and establishes a city typology. First, the morphological dimension is taken into account in order to characterize centres as historical or new. Three categories are distinguished within the NECs, according to the periods of greatest growth (NEC1, NEC2 and NEC3). Once medium-sized cities have been characterized in terms of their morphological attributes, the functional dimension is incorporated into the analysis. This second step considers the traditional intermediation approach—centrality index—new intermediation approach—measured through APS—as well as spatial organization capacities—measured through commuting flows.

4. Results

4.1. Morphological Dimension

The population evolution shows the role of radial motorway corridors (Figure 5) as growth vectors (Table 1). Municipalities outside the corridors have decreased by half their relative importance 21% of the total study area population in 1960 and 10.5% in 2011). Thus, the structure of the study area has re-concentrated over the motorway corridors.

The population distribution evolution between 1980 and nowadays shows the dismantling of the monocentric model. This evolution is characterized by an increased importance of the metropolitan centre (Madrid municipality) during the first study years 1960–1970 (from 56% in 1961 to 62% in 1970) and a progressive reduction since then (52% in 1981 to 40% in 2011). Nowadays there are four corridors (north-east with seven medium-size
Figure 5. Methodological approach followed in setting a city typology in metropolitan urban systems.

Source: Authors.
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</thead>
<tbody>
<tr>
<td>Madrid</td>
<td>1</td>
<td>2,259,931</td>
<td>3,146,071</td>
<td>3,188,297</td>
<td>3,084,673</td>
<td>2,957,058</td>
</tr>
<tr>
<td>North Corridors</td>
<td>89</td>
<td>54,037</td>
<td>86,497</td>
<td>162,924</td>
<td>221,348</td>
<td>301,603</td>
</tr>
<tr>
<td>North-east</td>
<td>79</td>
<td>111,641</td>
<td>190,748</td>
<td>407,731</td>
<td>483,905</td>
<td>560,249</td>
</tr>
<tr>
<td>East</td>
<td>93</td>
<td>166,203</td>
<td>156,200</td>
<td>161,971</td>
<td>184,183</td>
<td>221,897</td>
</tr>
<tr>
<td>South</td>
<td>27</td>
<td>151,976</td>
<td>201,784</td>
<td>277,978</td>
<td>300,867</td>
<td>344,494</td>
</tr>
<tr>
<td>South-west</td>
<td>43</td>
<td>102,380</td>
<td>172,973</td>
<td>417,013</td>
<td>530,503</td>
<td>608,415</td>
</tr>
<tr>
<td>West</td>
<td>61</td>
<td>132,997</td>
<td>188,199</td>
<td>432,788</td>
<td>496,115</td>
<td>545,518</td>
</tr>
<tr>
<td>North-west</td>
<td>91</td>
<td>168,575</td>
<td>196,373</td>
<td>283,539</td>
<td>376,788</td>
<td>525,354</td>
</tr>
<tr>
<td>Total corridors</td>
<td>483</td>
<td>887,809</td>
<td>1,192,774</td>
<td>2,143,944</td>
<td>2,593,709</td>
<td>3,107,530</td>
</tr>
<tr>
<td>Rest of municipalities</td>
<td>906</td>
<td>856,863</td>
<td>694,238</td>
<td>727,289</td>
<td>741,130</td>
<td>768,509</td>
</tr>
<tr>
<td>Total</td>
<td>1390</td>
<td>4,004,603</td>
<td>5,033,083</td>
<td>6,059,530</td>
<td>6,419,512</td>
<td>6,833,097</td>
</tr>
</tbody>
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</tr>
</thead>
<tbody>
<tr>
<td>Madrid</td>
<td>1</td>
<td>886,140</td>
<td>42,226</td>
<td>–103,624</td>
<td>–127,615</td>
</tr>
<tr>
<td>North Corridors</td>
<td>89</td>
<td>32,460</td>
<td>76,427</td>
<td>58,424</td>
<td>80,255</td>
</tr>
<tr>
<td>North-east</td>
<td>79</td>
<td>79,107</td>
<td>216,983</td>
<td>76,174</td>
<td>76,344</td>
</tr>
<tr>
<td>East</td>
<td>93</td>
<td>–10,003</td>
<td>5771</td>
<td>22,212</td>
<td>37,714</td>
</tr>
<tr>
<td>South</td>
<td>27</td>
<td>49,808</td>
<td>76,194</td>
<td>22,889</td>
<td>43,627</td>
</tr>
<tr>
<td>South-west</td>
<td>43</td>
<td>70,593</td>
<td>244,040</td>
<td>113,490</td>
<td>77,912</td>
</tr>
<tr>
<td>West</td>
<td>61</td>
<td>55,202</td>
<td>244,589</td>
<td>63,327</td>
<td>49,403</td>
</tr>
<tr>
<td>North-west</td>
<td>91</td>
<td>27,798</td>
<td>87,166</td>
<td>93,249</td>
<td>148,566</td>
</tr>
<tr>
<td>Total corridors</td>
<td>483</td>
<td>304,965</td>
<td>951,170</td>
<td>449,765</td>
<td>513,821</td>
</tr>
<tr>
<td>Rest of municipalities</td>
<td>906</td>
<td>–162,625</td>
<td>33,051</td>
<td>13,841</td>
<td>27,379</td>
</tr>
<tr>
<td>Total</td>
<td>1390</td>
<td>1,028,480</td>
<td>1,026,447</td>
<td>359,982</td>
<td>413,585</td>
</tr>
</tbody>
</table>

cities, south-west with five, west with four and north-west with seven) with more than half a million inhabitants, two corridors (north with five medium-sized cities and east with three) with less than half a million and one corridor (south with five medium-sized cities) with almost that population (see Table 1 and Figure 1).

The conclusions from the population evolution of medium-sized cities in relation to their proximity to Madrid and their location in each radial corridor are the following (see Figure 6):

- The study area has evolved from only eight medium-sized cities, in 1960 all of them historical, five HACs and three HECs, to include also 31 NECs in 2011, 9 of these NEC-1, 3 of them NEC-2 and 5 NEC-3 (see Figure 5 in Section 3 and Table 2).
- During the study period all NEC cities were generated less than 50 km away from Madrid, 10 were generated between 25 and 50 km away from Madrid and 20 were generated within 25 km of Madrid. All the medium-sized cities more than 50 km away from Madrid are historical ones. This confirms the existence of the centrifugal path described in Section 3.2.
- The five HAC cities, all of them between 50 and 150 km from Madrid, have grown, although at a slow pace.
- The three HEC cities have grown differently. The one closest to Madrid (Alcalá de Henares), just outside the 25 km ring and in the second-most populated corridor (north-east), has undergone rapid growth. The two that are further away have grown slowly, one (Aranjuez), just inside the 50 km ring, in a much less populated corridor (south), and the other (Talavera de la Reina) just inside the 150 km ring along an average populated corridor.
- The presence of HACs and HECs less than 100 km distance is leading to a more policentric urban sub-system along their corridors (NE, SW and NW). These corridors show a continuous and elongated physiognomy and favour the development of the incorporation path described in Section 3.2. The lack of HACs in a corridor, the presence of HACs more than 100 km away from Madrid or the presence only of HECs (with no HACs) produces a concentration of medium-sized cities (and of the whole corridor) only very close to Madrid and a weaker polycentric urban sub-system—north, south and west corridors—or even corridors without structure—east.

4.2. Intermediary Roles

As indicated in the methodology, medium-sized cities are considered to have developed centrality roles—the traditional intermediary approach—in 2011 if they reached a good score (Medium-High) in the sum at of the political, economic and connectivity centrality features. In the case of Madrid, this happens in 44% of medium-sized cities (17 out of 39), which reached in 2011 a total Index of Centrality of at least seven in 2011, and include the following medium-sized cities types and 1981–2011 trajectories (Table 2):

- All five HACs already had important centrality levels in 1981, have the highest levels in 2011 and increased their centrality capacities only one step from Medium-High to High.
- Only one of the three HECs, the biggest and closest to the metropolitan core (Alcalá de Henares), improved its capacity considerably (two steps) from Low to Medium-High.
Figure 6. Population evolution of medium-sized municipalities in the Madrid study area along the radial corridors.
Table 2. Evolution (1981–2011) of Centrality Capacity Indexes

<table>
<thead>
<tr>
<th>Name</th>
<th>Type of medium-size city</th>
<th>Number used in Figure 1</th>
<th>Distance to Madrid (km)</th>
<th>Population 2011</th>
<th>Political</th>
<th>Economic</th>
<th>Connectivity</th>
<th>Total</th>
<th>Evolution of Indexes (1981–2011)</th>
<th>Type of city according to APS and APS/inhabitant concentration (2007)</th>
<th>Mobility patterns (commuting) (absolute data and % over total)</th>
<th>Horizontal (between medium-sized cities)</th>
<th>Hierarchy (from the rest of the metropolitan settlement)</th>
<th>Total</th>
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<td>1–3</td>
<td>6–13</td>
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<td>B (9800—13.2)</td>
<td>145 4.1% 207 5.9% 3147 89.9% 3499</td>
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<td>7975—12.6</td>
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<td>Without–Medium-High</td>
<td>2513—2.5</td>
<td>1777 28.3% 2927 46.6% 1578 25.1% 6282</td>
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<td>7289—8.5</td>
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<th>Name</th>
<th>Type of medium-size city</th>
<th>Number used in Figure 1</th>
<th>Distance to Madrid (km)</th>
<th>Population 2011</th>
<th>Political</th>
<th>Economic</th>
<th>Connectivity</th>
<th>Total</th>
<th>Evolution of type of centrality (1981–2011)</th>
<th>Evolution of type of centrality according to APS and APS/inhabitant concentration (2007)</th>
<th>Type of city according to APS and APS/inhabitant concentration (2007)</th>
<th>Mobility patterns (commuting) (absolute data and % over total)</th>
<th>Horizontal (between medium-sized cities)</th>
<th>Hierarchy (from the rest of the metropolitan settlement)</th>
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<td>1–2</td>
<td>Low–Low</td>
<td>C (1868—10.1)</td>
<td>1368</td>
<td>32.6%</td>
<td>1855</td>
<td>44.2%</td>
<td>974</td>
</tr>
</tbody>
</table>

Source: Authors.

Abbreviations: A—intermediary cities (>10,000 workers in APS and >10 APS/habitant); B—possible future intermediary cities (>7000 workers in APS and >8 APS/habitant); C—non-intermediary cities (<7000 workers in APS and/or <8 APS/habitant).
• Most NEC-1 cities, 7 of 10, improved their capacity considerably (two steps) from Low to Medium-High, and covered all but the east corridor.
• Only a few NEC-2s, 3 of 12, one very large (Fuenlabrada) and the other two much smaller and in the same north-west corridor (Pozuelo de Alarcón and Majadahonda), considerably improved their centrality levels. Two of them (Fuenlabrada and Pozuelo de Alarcon) advanced significantly (two steps) from Low to Medium-High capacities, while the third (Majadahonda) advanced considerably (three steps), from Without to Medium-High capacity.
• Only one of the nine NEC-3s, quite a small one (Arganda del Rey) and the only one in the east corridor, advanced considerably (three steps), from Without to Medium-High capacity.

The centrality capacities of HACs have been reinforced due to the decentralization of Spain since the 1980s (Estado de las Autonomías) (Ganau & Vilagrasa, 2003; Solís et al., 2012). NECs having the greatest centrality levels are those that (1) obtain the effects of population and employment diffusion earlier and/or are closer to Madrid and (2) have been favoured by new transport infrastructures (motorways, suburban rail or metro)10 (López de Lucio, 2003; Puebla, 1991; Solís et al., 2012).

As indicated in the methodology, the new intermediary approach is measured by each city’s absolute APS employment and by its relative one (APS jobs/100 inhabitants). Based on these data (Table 2) two categories can be proposed:

(a) Metropolitan intermediary cities (Table 2): Just about one fourth of all medium-sized cities, 11 of 39, 4 HACs and 7 NECs, have more than 10,000 APS jobs and more than 10 APS jobs per 100 inhabitants. For these cities:

• Size is not a determinant: They are neither the biggest nor the smallest ones, all having between 40,000 and 170,000 inhabitants.
• Proximity to the metropolis is relevant, since the seven NECs are less than 25–30 km from it.
• Proximity only gets less important when there is a strong politico-administrative role, and this happens in four HACs which are more distant. Nevertheless the most distant HAC (Cuenca) is not in this type of cities.
• The surrounding areas (corridor or sector) are relevant since the smallest six NECs are in the north and north-west corridors, which are the socially and environmentally most highly prized areas that attract a qualified, high-income population, plus a high presence of APS and a very weak manufacturing base.11 The only other NEC is bigger and it is its size which allows fulfilling the APS activity, while being located in an area with more manufacturing (south corridor).
• Only one NEC (Getafe) has a high supply of APS and a manufacturing base that is still important, as well as achieving full insertion in the knowledge society and economy. Local actors have favoured its industrial transformation into an industrial knowledge and innovation economy (Méndez et al., 2008).

(b) Metropolitan cities without a proper intermediary role at present:

(b.1) Possible future intermediary metropolitan cities (Table 2). Only 10% of all medium-sized cities—4 of 39—have more than 5000 APS jobs and more than 8 APS jobs per 100
inhabitants and their possible future intermediary role will depend on their evolution. These cities are very diverse:

- The second biggest medium-sized city Alcalá de Henares is a HEC located 25 km from the metropolitan centre and half way between this centre and one of the intermediary HACs (Guadalajara).
- A NEC-2 (Majdahonda) with almost 70,000 inhabitants and located not far from the metropolitan centre (34 km) and near three intermediary cities (Boadilla del Monte, Pozuelo de Alarcón and Rozas de Madrid) in one of the most highly priced corridors (north-west).
- The two others are the most distant historical cities: The smallest HAC (Cuenca) and a HEC (Talavera de la Reina), both of them located in quite isolated environments.

(b.2) **Non-intermediary cities** (Table 2). Just above 60% of all medium-sized cities—24 of 39—are strongly based on manufacturing or distributing standardized products such as agrarian, industrial or related to building activity as well as delivering standardized population services such as health, education or culture and have a long way to go to reach a significant number of APS jobs and relevant APS jobs/inhabitant ratio.

The growth of APS since the 1980s has contributed to the repositioning of cities as centres of economic growth and as central nodes in the world economy (Hall & Pain, 2006; Taylor, 2012b). The questions that should be asked are in which cities a high level of the intermediary traditional approach—intermediary traditional ranking (ITR)—is linked and/or favours a high level of intermediary new approach—intermediary new ranking (INR)—and vice versa, and in which cities a high level of intermediary traditional is linked to a low level of intermediary new approach and vice versa.

The comparison of each medium-sized city ITR and INR together with each city spatial articulation capacity derived from commuting flows in Madrid shows the following results (Figures 7–9).

(a) **High levels of ITR and INR** take place in one fifth of all medium-sized cities—9 of 39.

(a.1) **Four HAC cities**: Toledo (2nd position in INR and 1st position in ITR), Ávila (10th in INR and 4th in ITR), Guadalajara (6th in INR and 2nd in ITR) and Segovia (11th in INR and 5th in ITR). These HACs act as organizing nodes of administrative territories (provinces) and at the same time of metropolitan territories. In this way, a new metropolitan externality arena up to 100 km distance from Madrid is defined. The commuting flows of these cities support these urban roles because hierarchical flows are losing importance while the non-hierarchical and tangential ones are gaining importance.

(a.2) **Five NEC cities**: Alcobendas (1st position in INR and 16th position in ITR), Pozuelo de Alarcón (3rd in INR and 12th in ITR), Getafe (5th in INR and 10th in ITR) and San Sebastián de los Reyes (7th in INR and 17th in ITR). They are cities located close to Madrid—less than 30 km away—that are very interlinked with the metropolis and the other medium-sized cities, with more than 70% of their incoming commuting flows being non-hierarchical (from Madrid) and tangential.
**Figure 7. City typology.**

*Source: Authors.*
Figure 8. Commuting (1981–2001).
(b) Low levels of ITR and INR: These are cities with low or medium-low centrality index and non-intermediary cities according to APS concentration and it happens in almost half of all medium-sized cities, 18 of 39.

**Figure 9.** Metropolitan urban system in evolution. *Source:* Authors.
(c) **A high level of ITR and a medium level of INR**: These are cities with high or medium-high centrality index and possible future intermediary metropolitan roles according to APS concentration. There is a HAC (Cuenca: 15th position in INR and 3rd position in ITR), a NEC (Mahadahonda, 12th in INR and 14th in ITR) and two HECs (Talavera de la Reina, 13th position in INR and 20th position in ITR and Alcalá de Henares, 14th in INR and 7th in ITR).

(d) A contradictory combination of ITR and INR, either high ITR and low INR or vice versa:

(d.1) **Metropolitan intermediary cities—high INR—with low or medium-low centrality index—low ITR**: Tres Cantos (2nd position in INR and 29th position in ITR), Rozas de Madrid (4th in INR and 21st in ITR) and Boadilla del Monte (8th in INR and 22nd in ITR). These are mostly fairly small medium-sized cities and are located in predominantly tertiary corridors.

(d.2) **Non-intermediary cities—low INR—with medium-high centrality index—high ITR**: Móstoles (16th position in INR and 6th position in ITR), Alcorcón (11th in INR and 18th in ITR), Fuenlabrada (8th in INR and 19th in ITR), Arganda del Rey (15th in INR and 25th in ITR), Leganés (9th in INR and 17th in ITR) and Coslada (13th in INR and 21st in ITR). These are mostly fairly big medium-sized cities and are located in predominantly manufacturing corridors.

5. Conclusions

This article argues that the current process of globalization is leading to a new form of spatial organization of metropolitan systems characterized by a quadruple process:

(a) An interweaving of the metropolitan system and the national urban system around it led by medium-sized cities not previously integrated in metropolitan processes. A new metropolitan scale is emerging. According to the Madrid results this happens up to 100 km distance.

(b) The new metropolitan systems are evolving toward a dual system of cities with a sub-central role, as a result of differentiating the intermediary traditional approach (based on centrality index) and the intermediary new approach (based on APS concentration). According to this distinction the article distinguishes between (1) **metropolitan intermediary cities**, the top medium-sized cities and new globalization anchors; and (2) **metropolitan cities**, the remaining medium-sized cities, those that connect goods and services between rural areas and the rest of the urban system.

(c) The development and the generation of medium-sized cities take place besides transportation corridors. Within this, those historic administrative cities located along corridors not too far away from the metropolitan centre (in the case of Madrid less than 100 km) favour the generation along them of clusters of elongated sub-systems of cities with a greater number of medium-sized cities. Contrarily, the absence of historic administrative cities or their location further away from the metropolitan centre (in the Madrid case more than 100 km) evidences that the medium-sized sub-systems of cities along these corridors have less cities and are located more close to the metropolitan centre.
Together with the metropolises, the metropolitan intermediary cities, composed by a selective group of NECs and historic cities, shape an emerging global multicore-network at metropolitan-regional scale.

Factors facilitating the generation of metropolitan intermediary cities are diverse. Size is not a determinant factor. A combination of several of the following factors helps: (a) proximity to the metropolis, which, although it is tempered by the socioeconomic trajectory of the city, is relevant because having a tertiary-type economic base promotes the concentration of APS; (b) an important politico-administrative role; (c) location at the socially and environmentally most highly prized areas and (d) the ability among public and private agents to change the economic base.

Future research should (1) analyse the relationships between inter-firm APS and inter-city APS and examine the social and spatial functional division; (2) explore the conditions, opportunities and obstacles, as a result of public and private agent’s strategies for achieving greater functional, economic and institutional weight and (3) advance towards a new settlement morphotipology by considering the physical characteristics of the territorial support (to what extent landscape conditions urban growth and/or facilitates the attraction of economic activities) and the urban characteristics of the territorial support (to what extent each city shows a recognizable and interconnected urban structure and whether this facilitates the attraction of population and economic activities).

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Notes

1. The general notion of producer services’ role in economic development is underpinned by the assumption of their role as intermediaries between consumer services and manufacturing. Indeed, they are viewed in the world cities literature as “basing points” (spatial and organizational) for the global economy. Advance producer services (APS) isa cluster of activities that provide specialized services, embodying professional knowledge and processing specialized information, to other service sectors. Such knowledge-intensive services, provided by specialist consultancies, are a central feature of a new post-industrial economy, reflecting an acceleration of technological change based especially on micro-electronics, information and computer technology, new materials and biotechnology. (Hall & Pain, 2006, p. 4)


3. Even within the English-speaking world there is no one standard definition of a city: the term may be used for a town possessing city status; for an urban locality exceeding an arbitrary population size or for a town dominating other towns with particular regional economic or administrative significance.

4. This process is related to the spatial rationalization of the development of public service locations by the nation-state.

5. Concerning distance notion re-elaboration, two concepts are introduced/differentiated: geographical proximity (production and transaction costs reduction) and sociocultural proximity (shared behavioural
and cognitive codes). This leads to improving the relational capital, considered as those attitudes of cooperation and socialization, trust and reputation, and cohesion and belongings which facilitate cognitive successes—reduction of uncertainty, *ex ante* coordination and collective learning—and finally, economic successes.

6. Advance producer services have over the past three decades rapidly evolved into very central and highly knowledge-intensive features of today’s post-industrial economy, and firms have emerged as active agents in the creation and circulation of knowledge in local and regional economies (Coffey, 2000).

7. An intermediation function is responsible for managing the flows of people, goods, capital, information and knowledge that run the system.

8. The morphologic and functional dimension that characterizes urban structures is conditioned by the changes in the development policies (Solís *et al.*, 2013) and the underlying economic pressures—see De Santiago (2007) for the Madrid case. While there are very general planning guidelines for Castilla y León and Castilla-La Mancha regions, there does not exist a explicit planning policy for the whole metropolitan functional region (Valenzuela, 2011); rather on the contrary, a territorial structure tied together by the labour, consumption transport markets/networks and conducted by sectorial policies lies (De Santiago, 2007).

9. The timing of these processes has been studied by Solís (2011) and Solís *et al.* (2012).

10. The rapid growth of cities around Madrid (<30 km) is facilitated by a transport network (roads, railway and metro) which was developped mainly since 1990. Over and above the traditional radial infrastructures (roads and railway), it contains an orbital railway line and a set or orbital highways (M40, M-45 and M50). The metro was prolonged outside the municipality of Madrid reaching most of the adjacent ones (Alcobendas and San Sebastián to the north; Coslada and San Fernando de Henares to the east; Rivas-Vaciamadrid and Arganda del Rey to the south-east; Fuenlabrada, Getafe, Alcorcón, Móstoles and Leganés to the south through what is called metro-sur; and Pozuelo and Boadilla del Monte to the west). On top, the radial highway network was duplicated up to the limits of the administrative Madrid region along half of the corridors, in particular duplicating the highways towards Guadalajara and Toledo (Del Río & Rodríguez, 2009; López de Lucio, 2003; Valenzuela, 2011). Suburban and/or high-speed rail has also been developed up to the capitals of the provinces adjacent to Madrid (Avila, Cuenca, Guadalajara, Segovia and Toledo).

11. Meñdez *et al.* (2009) and Solís *et al.* (2013), based on a historical analysis (over the last three decades) of the evolution of public and private policies to create a more attractive space for locating a more qualified population as well as companies linked to knowledge economies.

12. See the study by Meñdez *et al.* (2009) on functional structure and employment in the community of Madrid, in which they distinguish between distribution, production, regulation and intermediation. The first two categories are the most representative of those municipalities that have been designated as non-intermediary cities.

References


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Impacts of High-Speed Rail on Metropolitan Integration: An Examination of London, Madrid and Paris

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ABSTRACT The original goal of high-speed rail (HSR) was to link large metropolitan regions 400–600 km apart. Recently, however, intermediate ‘ex-metropolitan’ HSR stations have also been created in suburban areas/cities within metropolitan regions (up to 100 km from the metropolitan centre). This study takes a close look at nine such ‘ex-metropolitan’ stations around Madrid (Guadalajara, Segovia, and Toledo), London (Stratford, Ebbsfleet, and Ashford), and Paris (Charles-de-Gaulle, Marne-la-Vallee — Chessy, and Massy), to understand their territorial and local impacts and draw possible lessons for the California High Speed Rail project.

1. Introduction

Infrastructures play a decisive role in urban growth (Hoyle and Smith 1992). High-speed rail (HSR) is not an exception, leading to changes in accessibility and travel time, inducing modal shifts and new transport demands (Givoni 2006) and impacting territorial and local dynamics, such as reorganization of the urban hierarchy and city restructuring.

While the initial aim of HSR was to link metropolitan centres 400–600 km apart, HSR stations have been recently established in suburban areas and cities of European metropolitan regions, within 100 km distance from the metropolitan centre. We call such stations ‘ex-metropolitan’ and deem that they can play two roles: as new metropolitan suburban transport and as secondary metropolitan long-distance stations. Garmendia et al. (2012) conclude that although they provide limited long-distance connections compared to central metropolitan stations, such stations contribute to the avoidance of central station congestion and offer fast commuting to/from the metropolitan centre.

Ex-metropolitan stations may also reinforce the metropolitan integration of their surrounding areas (Garmendia, Ribalaygua, and Ureña 2012) making them potential centres of economic growth (Sands 1993; Burmeister and Colletis-Wahl 1996; Vickerman 1997; Rietveld et al. 2001; Ribalaygua 2005). Thanks to accessibility improvements, new
metropolitan subcentres can emerge in metropolitan regions (Martinez et al. 2014) fostering more complex and polycentric mobility patterns (Clark and Kuijpers-Linde 1994; Van der Laan 1998).

What territorial and urban location characteristics should ex-metropolitan HSR stations have to best take advantage of HSR? This paper seeks to address this question by examining the territorial and local impacts of ex-metropolitan HSR stations around London, Madrid, and Paris in order to draw lessons for other major metropolises. Following the introduction, Section 2 presents a literature review of the territorial and local impacts of HSR. Section 3 details the methodological approach, while Section 4 presents findings from the three metropolitan regions and nine ex-metropolitan HSR stations and Section 5 provides a taxonomy for such stations. The concluding section summarizes the lessons learned.

2. Literature Review: Territorial and Local Impacts of HSR

The HSR may bring about both territorial and local development effects such as improvement of a city’s position in the overall urban hierarchy, transformation of its spatial or economic structure, (re)development of its station area (Bellet, Alonso, and Gutiérrez 2012), and a positive city image (Ureña, Menerault, and Garmendia 2009). But such impacts can vary from one city to the other (Loukaitou-Sideris et al. 2013) depending on a station-city’s: (a) location in relation to other cities; (b) economic features and trajectory; (c) connectivity to main transport corridors and nodes; (d) type of HSR network and location in it; and (e) station location (central or peripheral) within each city (Ureña et al. 2012).

For a territorial scale (national or regional), scholars have argued that HSR facilitates polarization between first- and second-tier cities (Garmendia, Ribalaygua, and Ureña 2012). But while the former are the primary beneficiaries of the new infrastructure, HSR has also induced economic development in some small and intermediate cities (Ahlfeldt and Feddersen 2009; Hall 2009; Garmendia, Ribalaygua, and Ureña 2012; Garmendia et al. 2012).

Based on the Japanese experience, Rietveld et al. (2001) and Haynes (1997) concluded that HSR cities had greater employment growth than non-HSR cities. HSR has also contributed to firm centralization in first-tier cities, expanding their influence area and achieving economies of scale (Klein 2004). In some cities, HSR has had a significant impact on the distribution of jobs within the urban territory, as a number of employers concentrated around HSR stations (Cervero 2009). Some peripheral cities have also witnessed positive economic benefits because of improved accessibility and connectivity (Coto-Millán, Inglada, and Rey 2007; Preston and Wall 2008). However, not all studies have found noteworthy impacts from the HSR, with some scholars only observing minor effects (Haynes 1997).

In regard to ex-metropolitan stations, scholars have noted that some small and intermediate HSR cities close to the metropolis have increased their population, attracted new economic activities and housing investments, and now display the potential of becoming metropolitan subcentres (Garmendia, Ribalaygua, and Ureña 2012). Therefore, HSR can facilitate a reinforcement of continuous metropolitan integration within 30 minutes travel time (Ureña, Garmendia, and Coronado 2009; Garmendia, Ribalaygua, and Ureña 2012).

At the local scale, the HSR has been seen as a potential catalyst for economic development and improvement of deteriorated city areas. Experiences show that HSR services have been the central core of several successful city regeneration efforts (Willigers 2008; Hall 2009; Stanke 2009), encouraging cities to restructure their land uses around
station areas (Bellet, Alonso, and Gutiérrez 2012). The HSR in many medium-size Spanish cities such as Cordoba, Zaragoza, Lerida, and Valladolid has affected not only their station surroundings but also their overall city structure (Ureña, Menerault, and Garmendia 2009) and has reinforced their historic centralities. Some of these cities have witnessed new activities and public amenities and transport system improvements.

Such local and regional economic development impacts have resulted in increased land values around some stations even in intermediate cities (Haynes 1997; Banister and Berechman 2000; Rietveld et al. 2001; Gibbons and Machin 2005; Ahlfeldt 2013). Additionally, the presence of a new or renovated HSR station can add an image premium to an office address (Willigers 2003). However, also contradictory conclusions can be found in the literature, such as Ahlfeldt (2012) or Anderson, Shyr, and Fu (2010), who did not find any significant impact on the real estate market of station neighbourhoods of certain HSR cities. Other scholars have concluded that the mere existence of an HSR station is not enough to improve the economic dynamics of a city (Vickerman 1997; Givoni 2006; Ribalaygua 2006), although it may provide important comparative advantages (Ureña et al. 2006).

European studies show that to generate economic growth and substantial revitalization, municipalities must develop strategies that ensure the integration of HSR within the local economic and physical environment and take advantage of new HSR service opportunities (Plassard 1997; Van den Berg and Pol 1998; Bazin et al. 2006; Meer, Ribalaygua, and Martín 2012). Such strategies should include planning, management, and marketing measures (Van den Berg and Pol 1998). Additionally, two types of actions have been found to integrate the HSR with the urban fabric: (1) refurbishing the existing railway system (increasing its efficiency and integration) and (2) developing urban projects around the station area (Bellet, Alonso, and Gutiérrez 2012).

In terms of the location of HSR station within a city, the choice of central or peripheral sites has also been debated (Zembri 1992; Troin 1995; Mannone 1997; Auphan 2002). For some peripheral station locations, municipalities have created plans to use the HSR station as an attraction for further development, seeking to expand the city towards it. But in certain cases, this has not happened, while others have been successful (Facchinetti-Mannone 2009). In some French cities, ‘activity parks’ have been planned around peripheral stations but not much development has followed; others have only developed parking facilities. Thus, scholars have argued that central station locations can better develop synergies allowing new regeneration projects (Bellet, Alonso, and Gutiérrez 2012).

To sum up, the HSR effects are highly variable (Sands 1993), and additional research is necessary to better understand the factors that contribute to positive territorial and urban development patterns (Stanke 2009; Loukaitou-Sideris et al. 2013). Moreover, in order to fully understand the implications of HSR stations, the analysis should consider different spatial scales and the interrelation between them: the station surroundings, the local scale, and the regional/national scale.

3. **Research Hypotheses and Methodology**

The study examines the following hypotheses:

(a) Ex-metropolitan HSR stations may act as catalysts for territorial urban transformations (at the metropolitan scale). The type of station and its distance from the metropolitan centre are important factors that influence if this would happen.
Ex-metropolitan stations may act as catalysts for local transformations attracting population and jobs at metropolitan subcentres. This would depend on a number of factors including the type of HSR services offered, level of station intermodality, distance to the metropolis, station location, etc.

The study examined these hypotheses through case studies of nine European ex-metropolitan HSR stations in the metropolitan regions of London, Madrid, and Paris (Figure 1). We have considered only HSR stations less than 100 km or 30 minutes travel time on HSR from the metropolitan centres, since the area within this radius is typically considered part of the metropolitan region regardless of the existence of an HSR station. Population changes have been assessed before and after the introduction of the HSR in each city, taking into consideration the periods indicated by Serrano et al. (2006). Thus, for each case study, we examined differences in the annual population from the 1980s to the HSR station opening and from that moment up to 2012. Additionally, for each station area (boroughs in the UK, municipalities in Spain, and communes in France), a comparison with other appropriate areas of each metropolitan region (county/department, region, and metropolitan area) is made for the same study periods to fully appreciate whether population changes in the HSR area have followed similar trends as elsewhere or if, conversely, the HSR has substantially influenced population growth.

Because of data constraints, we collected more limited employment data (statistics are not available for the 1980s and 1990s). One challenge that the study faced was that it was often difficult to separate the impacts of the HSR from other forces. Nevertheless, we collected information about the following factors (data sources are gathered in Table 1):

- Territorial (metropolitan) scale:
  (i) changes in population size and comparison of these changes with those in the overall metropolitan region;

Figure 1. European HSR networks considered as case studies. (a) London metropolitan area; (b) Madrid metropolitan area; and (c) Paris metropolitan area. Note: Each circle represents 100 km around the metropolitan centre.

(a). 1.-St. Pancras; 2.-Stratford; 3.-Ebbsfleet; 4.-Ashford. – (b). 1.-Chamartín; 2.-Puerta de Atocha; 3.-Guadalajara; 4.-Segovia; 5.-Toledo. – (c). 1.- du Nord; 2.- de l’Est; 3.- de Lyon; 4.-Gare Montparnasse; 5.-Chessy - Marne-la-Vallée; 6.-Massy; 7.- Roissy – Charles de Gaulle.
(ii) changes in employment.
• Local scale (station and adjacent neighbourhood):
  (i) development of new station area plans;
  (ii) presence of new station area developments; and
  (iii) station area land uses before and after station opening.
• HSR network
  (i) changes in ridership.

4. The Case Studies

In the UK, the development of HSR infrastructure connecting London and the Continent, along with traffic congestion on motorways in the London metropolitan region, offered the opportunity to generate new HSR metropolitan suburban services, called domestic high-
speed, which connect the central London station (St Pancras) with the South East, partially along the HSR line and partially along conventional rail lines. In Spain, HSR regional services (AVANT) were established in 1992 to and from areas about 200 km from Madrid. More recently, HSR stations less than 100 km from Madrid and Barcelona have also been developed. In France, regional HSR services operate partly along the HSR network and partly along the conventional network; some of these services interconnect different French regions along the Paris HSR bypass that includes several HSR stations.

Today, each of the three metropolitan regions has three ex-metropolitan HSR stations (Figure 2). Madrid, the smallest metropolitan region in population, has two central terminus stations, one south (Atocha) and one north (Chamartín) of its Central Business District (CBD), and three quite distant ex-metropolitan stations: Guadalajara (59 km), Toledo (72 km), and Segovia (93 km), each on a different HSR radial line. London, the largest and most dispersed metropolitan region, has one central HSR terminus station north of its CBD (St Pancras) and three ex-metropolitan stations at increasing distances from the centre on the same and sole south-east HSR line: Stratford (9 km), Ebbsfleet (37 km), and Ashford (88 km). The Paris metropolitan region has four central terminus stations, each on one radial HSR line, south-east (Gare de Lyon), south-west (Montparnasse), north (Gare du Nord), and east (Gare de l’Est), and three ex-metropolitan stations along the bypass: Massy (24 km), Charles-de-Gaulle — Roissy at the Roissy Airport (23 km), and Marne-la-Vallée — Chessy at Euro Disney (26 km).

Figure 2. Population evolution (annual percentage) before and after the HSR station opening (the dots represent the value of the before–after annual population growth), while the connecting line indicates the rate of change in tendencies.

Source: Authors based on British, Spanish and French Official Statistics Institutes.
All three metropolitan regions have witnessed decentralization, multicentricity, and deindustrialization along with concurrent increases in their service economies. The number of commuters between these ex-metropolitan areas and the metropolitan centre was already high prior to the HSR (Preston and Wall 2008; Aguilera, Wenglenski, and Proulhac 2009; Martinez et al. 2014).

4.1. London

The Greater South East conurbation around London is a global polycentric megacity region with a large commuter catchment area and economic influence (De Goei et al. 2010). The outer areas to the west, in easier reach of Heathrow Airport, are the main destinations for newer high-technology employment.

London’s three ex-metropolitan HSR stations, while not on the new high-technology sector and at a distance from London’s main airports, seem nevertheless intelligently located from a territorial standpoint: the closest one (Stratford) to help expand the CBD by transforming a brownfield area into the site for the Olympics; the second one (Ebbsfleet), in an undeveloped transitional area, to help connect several adjacent urban areas and transportation infrastructures, and the furthest one (Ashford), on an important rail junction, to help increase the HSR accessible areas.

The boroughs of the three ex-metropolitan stations around London grew faster after the HSR station openings, experiencing a profound increase of their population after the HSR station opening, and compared to population growth at the metropolitan area and South East region (Figure 2). The annual population growth percentage of Stratford (the closest HSR station to the metropolitan centre) was the greatest and higher than that of the metropolitan core (Greater London Council). For Ebbsfleet, the rate of growth before and after the HSR station opening and the change in rate were relatively similar to the ones of the Greater London. Conversely, while the annual population growth of Ashford (the furthest from London) was greater than that of the metropolitan area, population increase after the station opening was somewhat lower than that for Greater London (Figure 2).

4.1.1. Stratford International. Opened in 2009, Stratford HSR station is located just north-east of the CBD (borough of Newham) (Figure 1) and is well connected to other transport infrastructures. The redevelopment that took place for the 2012 Olympics has transformed this brownfield area of underutilized railway tracks, warehouses, and vacant land into a mixed-use district. This regeneration project has reinforced the already substantial accessibility and connectivity of the site and has helped Stratford City to emerge as a new metropolitan subcentre (Rudi.net 2013).

The HSR station (Figure 3), 400 m away from the Stratford bus terminal and conventional/regional rail services, is only served by metropolitan mixed HSR. Within walking distance to the station, there is an 850-space multi-storey parking structure. A pedestrian connection links the station to a shopping centre and the Olympic Park. The depressed tracks become a tunnel at both ends, and connection between the two sides is allowed at six different points. The depressed rail station and tunnel help to mitigate the barrier effect and improve the connectivity of the area.

Two major projects are taking place in the station vicinity: the International Quarter, a mixed-use project, and the East Village E20 that converts the former Olympic Village into
residences. It is anticipated that up to 4500 new housing units and 30,000 new jobs will be created once the regeneration project is complete (Preston and Wall 2008).

The Stratford HSR station was planned as an additional asset of the redevelopment plan. It appears that long-distance HSR services combined with a strong redevelopment plan and metropolitan proximity will help Stratford become a metropolitan subcentre.

4.1.2. Ebbsfleet International. Opened in 2007, Ebbsfleet HSR station is just outside the Green Belt (Dartford and Gravesham boroughs) (Figure 4) in a metropolitan transition area, 400 m south-west from the Northfleet conventional rail station and served by metropolitan and long-distance HSR services. The station is close to major motorways and served by bus routes.

Although the Dartford borough population has witnessed a stable increase since the 1980s, the land in the immediate station vicinity is still mostly undeveloped. Indeed, not much has been built yet around this station (Figure 4). Large surface-parking areas (5237 parking spaces) temporarily occupy land that will be redeveloped when the Ebbs-fleet Valley regeneration plan takes place (Figure 5). The HSR station vicinity is planned to become residential, commercial and office/mixed use, with a pedestrian connection between both stations and replacing the surface parking with multi-storey garages. This area has been characterized as ‘a key development node in the Thames Gateway sub-region to create a new transport hub of regional significance’ (Gravesham Borough 2009, 5).

The surface rail tracks together with the big car parks and other transport infrastructures largely disconnect the station from its surrounding areas. It appears as if the station was
Figure 4. Ebbsfleet International station area before (2003) and after the HSR station opening (2012).

Figure 5. Ebbsfleet Valley master plan.  
Source: http://www.ebbsfleetvalley.co.uk/

located in the first open area opportunity south of the River Thames and has solely been thought of as a transportation junction rather than an urban node. It remains to be seen if the Ebbsfleet Valley master plan will be realized.
4.1.3. Ashford International. Ashford city, located at an important rail and road metropolitan and international corridor, is a historic rail junction and a centre for railway manufacturing and engineering. With the exception of its town centre, Ashford is a low-density housing and rural area, with no university or administrative services.

The conventional Ashford station, was remodelled and opened in 1996 for both conventional and HSR services. It has a few long-distance HSR services to Paris, Brussels, and a few other destinations (i.e. Euro Disney) and many mixed HSR metropolitan services. The station is located near the urban centre and major motorways making it easily accessible by foot and by car. It is used by some riders departing to/arriving from Europe, for whom it is more convenient than the St Pancras station, since it is well connected with the conventional railway network towards the rest of the South East and is more accessible by car (Garmendia et al. 2012).

HSR construction has further disconnected the station area from the rest of Ashford. The station vicinity has not attracted office development, although it has been recently designated as a growth area for the South East region, and its population is expected to double by 2031 (Preston and Wall 2008) with the development of 31,000 homes and 28,000 jobs (Jefford and Green 2004; Urban Initiatives 2005). Presently, development in Ashford falls significantly behind that of Ebbsfleet and Stratford.

Between 1991 and 2001, 430,000 m² of land was designated for commercial and industrial development although only 107,000 m² of this space has been built so far. Additionally, the construction of 6800 new dwellings was proposed, but only 5200 units have been completed (Preston and Wall 2008). Nevertheless, since 1996, property values in the Ashford district had by 2005 increased by 26.5%, which was higher than the South East average (23.2%) (Preston and Wall 2008). This was accompanied by a decline in commercial property vacancy rates (from 13% in 1998/1999 to 8% in 2004/2005) and a higher growth in the number of new businesses in Ashford than in the rest of the South East (Preston and Wall 2008). On the other hand, very few changes have taken place near the HSR station apart from the demolition of some industrial spaces, the erection of a new station building to the south of the tracks (connected to the urban centre by an underpass), some new rail facilities, a multi-storey parking structure, and a new shopping centre less than 1 km south of the station (Figure 6).

4.2. Madrid

Madrid has three distant ex-metropolitan HSR stations at the provincial capitals of Guadalajara and Segovia, and the regional capital of Toledo (Figure 1). Segovia is a through station, with long-distance services branching towards the north and north-west and metropolitan services. Guadalajara is also a through HSR station only with long-distance services towards the north-east (Madrid–Barcelona HSR line). Toledo is a terminus station only connected with Madrid through metropolitan services.

The population data from the three municipalities with HSR stations compared to those from the Madrid province and five adjacent provinces around it show quite similar acceleration tendencies for all but one case, when comparing before and after each HSR station creation (Figure 2). The exception happens in Segovia (the most recent HSR station), where annual population growth shows a stable decrease since the 1980s that has not been reversed by the opening of the HSR. It should be noted, however, that the long-distance HSR network towards the north of Spain is still under construction, so it is likely that
the impact of the station will be greater once the network is completed. The population effects of the three HSR stations in Spain are less evident possibly because of their newness, their important distance from the metropolitan centre, as well as Spain’s economic crisis. All three stations have been built very recently, only Guadalajara is slightly over 10 years old, in a period when Spain suffers a profound economic crisis. Despite the fact that population evolution does not show major effects of HSR stations compared to other regions, the three municipalities show greater growth in jobs than in inhabitants during the last 10 years (after the issuance of HSR station plans and construction) (Table 3). In Guadalajara and Toledo, the number of jobs has increased by 36% and 50%, respectively, while their population has increased by 25%; Segovia has not witnessed an increase in its population since the opening of the HSR but has increased its employment by approximately 18%.

4.2.1. Guadalajara. Guadalajara city is connected with Madrid by HSR, but also has good alternative transportation connections including two motorways, bus, and conventional suburban and national rail. Guadalajara has a double role: that of a central city to its province and a service and dormitory city at the north-east metropolitan corridor, but without a research university, high-quality hospitals, or office headquarters (Garmendia et al. 2012).

The HSR station that opened in 2003 has a peripheral location, 8.5 km from Guadalajara city centre and 12 km from the city’s conventional rail station (Figure 7). It has low ridership, no public transportation connection to the Guadalajara city centre, and lacks cheap metropolitan HSR services/fares (Table 3).

The distance and topographical barriers make it difficult to imagine the expansion of the city towards the new station. Nevertheless, a new development was planned, ‘Valdeluz city’ (Figure 7), to include 9500 dwellings, retail, industry, and amenities (business
4.2.2. Segovia. Segovia has a small private university, is a UNESCO World Heritage site, and has a double role: that of a central city to its province and a low-density province characterized by many second residences of Madrilenians. The city has been located 30 and 60 km distances from the national north-west road and rail corridors, respectively, while the HSR infrastructure has brought about a significant territorial change ending the city’s relative isolation. As a result of both the reduction in previous rail/road distances to Madrid (from 90 to 60 km) and the existence of affordable HSR services (25 minutes to/from Madrid), Segovia has also become better incorporated into Madrid’s metropolitan context. Indeed, in 2009, the HSR link registered almost 600,000 passengers, mainly commuters (Garmendia et al. 2012).

The HSR station is peripheral, located close to an industrial area, 6 km from the Segovia centre, 4.3 km from the traditional railway station, and at a similar distance from another small municipality, royal palace and second-homes area of La Granja de San Ildefonso (Figure 8). The HSR tracks are depressed and the station building bridges them and is
Figure 8. Local plans of the Segovia-Guiomar surrounding municipalities.

accessible from both sides. Adjacent, there is a 400-space parking area that is full every working day (Bellet, Alonso, and Gutiérrez 2012).

To address the challenges of its peripheral location, local plans seek to develop the area between the HSR and conventional rail station (Ribalaygua 2005) to achieve a better connectivity to the city centre (a road connection was already built by 2008). Moreover, two bus lines directly connect the centre with the HSR station, coordinating their arrivals with the HSR timetables (Bellet, Alonso, and Gutiérrez 2012). For the area between Segovia and La Granja, with the municipality of Palazuelos in between, the plans around the station propose the development of a new 500,000 m² neighbourhood with a mix of residential (1500 dwellings) and commercial/office land uses and a new 1,038,422 m² business park south of the current industrial area. There are also plans for a discontinuous linear urban area with abundant second homes and recreational (golf course and hotel complex) and retail uses (Bellet 2008 and Figure 9).

Despite the existence of available land and its location in the middle of a local corridor, the Segovia station area has not yet attracted new activity in its immediate vicinity (Figure 9). But notwithstanding the bad economic times and the newness of this station, some private development has already started and a number of local and sub-regional plans have been issued. It remains to be seen if land availability and the presence of the local corridor will act as opportunities for development, or if the peripheral station location will prove to be an obstacle.

4.2.3. Toledo. Toledo is a regional capital with some national relevance, a public research university, a very important tourist destination, and a UNESCO World Heritage site. It is connected to Madrid by bus and two motorways, as well as the HSR. Prior to the HSR, the city was also connected to Madrid by conventional suburban rail, which was dismantled.
The HSR is a terminus station located at the edge of the city centre, less than 2 km distance from the historic centre and the main office areas (Figure 10). The station location (within walking distance from the Toledo centre) and the sharp reduction in travel time (25 minutes on HSR instead of 90 minutes on conventional rail) have contributed to the significant use of the Madrid-Toledo HSR service (1.5 million passengers, 50% commuting and 30% leisure/tourism) (Table 3).

The HSR station is well connected to public bus lines and is near the bus station. The undeveloped land to the north side of the tracks, near the river, is envisioned by local plans (Figure 10) as a mixed office/housing development in the station’s vicinity (Bellet, Alonso, and Gutiérrez 2012; Meer, Ribalaygua, and Martín 2012), but no development has taken place so far (Figure 10).

4.3. Paris

Paris metropolitan decentralization follows a specific pattern (Halbert 2004): (1) business services in a widened metropolitan core; (2) high-technology and R&D activities in the south-west; and (3) downstream activities in secondary economic centres in the inner and outer suburbs of Paris.

The three ex-metropolitan station areas have witnessed an outstanding growth in high-order service jobs, but each of them has its own specificities: Marne-la-Vallée and Massy can be classified as ‘technopoles’ (specialized in high technology) and Roissy airport as a ‘downstream-activities economic centre’ (with activities such as logistics and wholesale trade) (Halbert 2004). All three ex-metropolitan HSR stations only have long-distance services. Thus, riders may use either central or ex-metropolitan stations depending on their initial origin or final destination.
Figure 10. Toledo HSR station area before (1997) and after the HSR station opening (2012).

While the three Paris HSR municipalities have increased their population over time, only two of them, the communes of Chessy and Massy, witnessed considerable increases in their population growth rates after the station opening, while the third one (Roissy-en-France commune) saw its growth rate decreasing. This may be because this area is mostly occupied by the Charles-de-Gaulle airport, and abundant offices and hotels have been created in the surrounding land, creating many new jobs but leaving no space for housing (Table 3). Comparatively, the larger departments where these stations are located as well as the Île de France region have experienced a lower annual population growth rate after the opening of the three HSR stations.

4.3.1. Marne-La-Vallée — Chessy. Built in 1992, the ex-metropolitan HSR station of Marne-la-Vallée — Chessy is located in the Chessy commune, 5.8 km from Chessy’s city centre, at the east end of the linear Marne-La-Vallée new town, and 4.5 km from the A4 motorway. The annual number of HSR passengers was 2.1 million in 2006 and grew by almost 25% to 2.6 million in 2008. According to the data provided by the French railway company (SNCF), in 2005, 50% of the HSR passengers used this station to access Euro Disney, 45% for professional reasons, and 5% for other purposes. About 15–20% of passengers lived in the east suburbs of Paris and used this station as an alternative to central HSR stations (Ureña, Garmendia, and Coronado 2009).

The HSR station, combined with the conventional metropolitan rail (RER), is located at the Disneyland Paris park entrance with underground tracks in its vicinity (Figure 11). It offers direct HSR connections to many national and a few international destinations. A large parking facility next to the HSR station is used by HSR passengers and Euro Disney visitors.
The intense high-technology activities located in the central part of Marne-la-Vallée, 10–15 km from the HSR station, are not found near the HSR station. Instead, Euro Disney has been given effective control over the structure and design of the emerging settlement around the station and is projected to develop two theme parks and up to 18,000 hotel rooms, 700,000 m$^2$ of commercial space, 700,000 m$^2$ of office space, and 7800 housing units (Bontje and Burdack 2005). But a significant amount of land is not developed yet (Figure 11). Apart from the theme park, a high-density housing and commercial development (Val d’ Europe) is taking place 1 km to the south of the HSR station (on the site of the previous metropolitan conventional station). Other developments (hotels and shopping centres) have appeared around the HSR station, mainly oriented to the leisure/tourism sector (Figure 11).

4.3.2. Massy. Built in 1991 for the HSR south-west line (LGV Atlantique), the Massy HSR station is located 0.8 km from the Massy city centre, traditionally a railway junction/station and an industrial and residential area. The HSR station is adjacent to the conventional long-distance and metropolitan (RER) Massy-Palaiseau train station, which is served by several bus lines, and is 15.4 km from Orly airport. This strategic location allows the station to serve riders from the southern Parisian suburbs, and its annual traffic has doubled in seven years, from 700,000 passengers in 2001 to 1.4 million in 2008.

The HSR station area has supported the transformation of this suburban area into a technopole (Bontje and Burdack 2005), following the state’s decision to relocate several research and university facilities from the centre of Paris to take advantage of favourable
location characteristics (vacant land, good transport linkages, and amenity-rich area). Thus, the HSR station has sparked new development in its vicinity. During the last 10 years, a number of actions have been carried out to improve the station area’s role as a multimodal node, technology pole, and residential area. First, the ‘Atlantis’ project, a mixed-use business park and residential neighbourhood to the east of the tracks, has transformed the former industrial land (Figure 12) and has added nearly 12,000 jobs. Second, the Vilmorin neighbourhood to the west of the tracks is also the site for redevelopment projects with residential and commercial uses, service, and leisure activities. A new pedestrian bridge has improved the connection between the two sides of the tracks. The metropolitan rail station was enhanced by a new building and the provision of more parking. Finally, the existing bus station, east of the tracks, was improved with a new building, a new bus station and parking area have been created to the west of the tracks, and the open areas besides them have been redesigned (Figure 12).

4.3.3. Roissy — Charles-de-Gaulle. Opened in 1994, this combined metropolitan (RER) and HSR ex-metropolitan station is located under Terminal 2 of the Charles-de-Gaulle airport and 9.7 km from the city centre of the Tremblay-en-France commune. The station offers direct HSR connections to many national and international locations. The Roissy — Charles-de-Gaulle airport is a secondary economic centre with an important component of high-order service jobs (Halbert 2004, 2007).

In 2004, 10 years after its opening, 2.4 million HSR passengers used the station, and this number increased to 4 million riders in 2011; 70% of these riders had matching HSR—plane connections, 10% matching HSR—HSR connections, while 20% travelled to other regional destinations by other means of transport (mainly by RER). However, the use
of the HSR station by the surrounding population remains low (about 3%), because of its poor connectivity to neighbouring towns and office areas.

A few new buildings have been developed within 800 m from the station and all are related to the airport facilities. Two new projects are Airport City and Aéroville. Airport City (at Roissypôle), close to the north of Terminal 2 and the HSR station, is a complex of hotels and office buildings, which currently includes 216,000 m² of office space and 68,000 m² of hotels (Figure 13). Aéroville is located at the western edge of the airport and provides 84,000 m² of retail space (Figure 13). It is difficult to isolate the impact of the HSR from the impact of the airport in the development of these projects.

5. Towards an Ex-metropolitan HSR Station Taxonomy

The nine ex-metropolitan stations studied may all be within 100 km distance from their metropolitan centre; however, they differ in a number of attributes that may affect their local and territorial impacts. To better understand the impact of different types of stations, we created a taxonomy taking into account the following factors (Table 2).

- **Placement of the city/urban area in the metropolitan region.** This was measured by the distance of the ex-metropolitan station from the metropolitan centre. We distinguished three categories of stations: (1) continuous (within a continuous urban area extending from the metropolitan centre and up 20–25 km from London, Madrid, or Paris); (2) transitional (at semi-urban, low-density peripheries of the metropolitan region, 20–35 km away from London, Madrid, or Paris); and (3) discontinuous (separated from the centre by undeveloped or rural land, generally at greater distances than the previous two cases).
- **Characteristics of the city/urban area.** We classified cities by (1) population size as small (up to 50,000 residents), medium (50,000–150,000 residents), or large (over
<table>
<thead>
<tr>
<th>Type</th>
<th>Ex-metro stations (metro area)</th>
<th>Placement</th>
<th>City/urban-area characteristics: demographic size, role, and travel</th>
<th>Transport networks and services (Figure 14)</th>
<th>Station location within the city and mass transport connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type I</td>
<td>Guadalajara (Madrid)</td>
<td>Discontinuous</td>
<td>• Medium&lt;br&gt;• Provincial capital&lt;br&gt;• Mixed</td>
<td>• Through radial (a.1.)&lt;br&gt;• Ex-urban (b.2.)</td>
<td>• Peripheral&lt;br&gt;Non-intermodal</td>
</tr>
<tr>
<td></td>
<td>Segovia (Madrid)</td>
<td>Discontinuous</td>
<td>• Small&lt;br&gt;• Provincial capital&lt;br&gt;• Mixed</td>
<td>• Through several radial (a.4.)&lt;br&gt;• Ex-urban (b.2.)</td>
<td>• Peripheral&lt;br&gt;Non-intermodal</td>
</tr>
<tr>
<td>Type II</td>
<td>Chessy — Marne-la-Vallée (Paris)</td>
<td>Transitional</td>
<td>• Small&lt;br&gt;• Theme park&lt;br&gt;• Destination</td>
<td>• Through tangential (a.3.)&lt;br&gt;• Urban (b.4.)</td>
<td>• Central (at Euro Disney)&lt;br&gt;Highly intermodal</td>
</tr>
<tr>
<td></td>
<td>Roissy — Charles-de-Gaulle Paris</td>
<td>Transitional</td>
<td>• Small&lt;br&gt;• Airport&lt;br&gt;• Mixed</td>
<td>• Through tangential (a.3.)&lt;br&gt;• Urban (b.4.)</td>
<td>• Central (at airport)&lt;br&gt;Highly intermodal</td>
</tr>
<tr>
<td>Type III</td>
<td>Massy (Paris)</td>
<td>Continuous</td>
<td>• Small&lt;br&gt;• Rail junction&lt;br&gt;• Mixed</td>
<td>• Through radial and tangential (a.1 and a.3.)&lt;br&gt;• Urban (b.4.)</td>
<td>• Central&lt;br&gt;Highly intermodal</td>
</tr>
<tr>
<td></td>
<td>Stratford (London)</td>
<td>Continuous</td>
<td>• Large&lt;br&gt;• 2012 Olympics&lt;br&gt;• Mixed</td>
<td>• Through radial (a.1.)&lt;br&gt;• Urban (b.4.)</td>
<td>• Central&lt;br&gt;Intermodal</td>
</tr>
<tr>
<td>Type IV</td>
<td>Ebbsfleet (London)</td>
<td>Transitional</td>
<td>• Medium&lt;br&gt;• N/A&lt;br&gt;• Origin</td>
<td>• Through radial (a.1.)&lt;br&gt;• Pure mixed (b.5.)</td>
<td>• Edge&lt;br&gt;Intermodal</td>
</tr>
<tr>
<td>Type V</td>
<td>Ashford (London)</td>
<td>Discontinuous</td>
<td>• Medium&lt;br&gt;• Rail junction&lt;br&gt;• Mixed</td>
<td>• Through radial (a.1.)&lt;br&gt;• Pure mixed (b.5.)</td>
<td>• Central&lt;br&gt;Highly intermodal</td>
</tr>
<tr>
<td>Type VI</td>
<td>Toledo (Madrid)</td>
<td>Discontinuous</td>
<td>• Medium&lt;br&gt;• Regional capital&lt;br&gt;• Mixed</td>
<td>• Dead end (a.2.)&lt;br&gt;• Urban (b.4.)</td>
<td>• Central&lt;br&gt;Intermodal</td>
</tr>
</tbody>
</table>

Source: Authors.
150,000); (2) administrative or other important functions (e.g. county, provincial, or regional capital, airport city, major theme park); and (3) travel activity (e.g. origin city, destination city, or both).
<table>
<thead>
<tr>
<th>Metropolitan area</th>
<th>London metropolitan area</th>
<th>Madrid metropolitan area</th>
<th>Paris metropolitan area</th>
<th>Roissy — Charles-de-Gaulle (1994)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Road) Distance to metropolitan centre</td>
<td>11 km</td>
<td>38 km</td>
<td>90 km</td>
<td>59 km</td>
</tr>
<tr>
<td>Land use at station site (prior to the HSR)</td>
<td>Brownfield</td>
<td>Brownfield (former chalk quarries)</td>
<td>Rail and manufacturing</td>
<td>Rural area (vacant)</td>
</tr>
<tr>
<td>Station location</td>
<td>North-east London CBD</td>
<td>3.1 km from Swanscombe</td>
<td>Adjacent to city centre</td>
<td>10 km from Guadalajara</td>
</tr>
<tr>
<td>Population</td>
<td>1981</td>
<td>211,900 (1)</td>
<td>81,300 (2)</td>
<td>92,200 (2)</td>
</tr>
<tr>
<td>Station opening 2011</td>
<td>286,400 (1)</td>
<td>3.1 km from Swanscombe</td>
<td>Adjacent to city centre</td>
<td>10 km from Guadalajara</td>
</tr>
<tr>
<td>Number of jobs Before HSR opening 2011</td>
<td>79,000 (2000)</td>
<td>98,900 (2)</td>
<td>120,100 (3)</td>
<td>84,504</td>
</tr>
<tr>
<td>Type of tracks</td>
<td>Depressed tracks</td>
<td>Level tracks</td>
<td>Level tracks</td>
<td>Level tracks</td>
</tr>
</tbody>
</table>

(Continued)
<table>
<thead>
<tr>
<th>Metropolitan area</th>
<th>London metropolitan area</th>
<th>Madrid metropolitan area</th>
<th>Paris metropolitan area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distance to other transportation modes serving the station</td>
<td>400 m from Stratford regional station. DLR</td>
<td>400 m from Northfleet conventional rail station. Dover—Canterbury—London Victoria bus route and Fastrack bus rapid transit</td>
<td>Adjacent to Ashford conventional train station</td>
</tr>
<tr>
<td>Land uses at the station area</td>
<td>Railway, warehouses, and vacant land</td>
<td>Brownfield (former chalk quarries)</td>
<td>Mixed use</td>
</tr>
<tr>
<td>Before HSR</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>After HSR</td>
<td>Mixed use: London Olympic Park. Westfield shopping mall</td>
<td>Parking areas</td>
<td>Mixed use (few changes)</td>
</tr>
<tr>
<td>Projected</td>
<td>Ebbsfleet Valley regeneration project (residential, commercial, and educational facilities)</td>
<td>‘Prado del Hoyo’ business districts</td>
<td></td>
</tr>
</tbody>
</table>

**Source:** Authors.  
• **HSR network characteristics.** We considered two aspects of the HSR network: (1) connections (e.g. radial versus tangential and through versus dead-end) (Figure 14); and (2) services (e.g. pure HSR or mixed services).

• **Station location within the city/urban area.** We distinguished between stations located at (1) the city centre; (2) city edge; or (3) peripheral/ex-urban locations.

• **Transportation connections.** HSR stations may have different types of connections to other modes of mass transportation. We distinguished between (1) non-intermodal, when there are no connections with other long-distance transportation modes (for instance, if there are only local buses serving the station); (2) intermodal, if long-distance transportation modes are within a walkable distance (800 m approximately); and (3) highly intermodal, if long-distance transportation modes are at the same building or in a really close proximity.

### 6. Lessons for New Ex-metropolitan HSR Stations

The nine ex-metropolitan stations and their vicinities have experienced different territorial and locational impacts depending on the context, the physical, economic, and locational circumstances, and the HSR network/services characteristics (Tables 2 and 3). In general, we found that the annual percentage population growth in the administrative units where the HSR station is located has been higher after the opening of the HSR station; in some cases (e.g. Guadalajara, Ebbsfleet, Massy, Ashford, or Toledo) moderately, in other cases (e.g. Chessy or Stratford) more significantly. Exceptions appeared only in the very recently built station of Segovia and in the airport station of Roissy that has developed into an employment centre. In all cases, however, population changes around the HSR have been more significant than those of the wider region where each station is located, indicating that HSR ex-metropolitan stations play a significant role in promoting population growth.

The impact on jobs was more uneven and cannot be generally attributed to the HSR as it was influenced by the general economy and the existence/proximity of particular employment poles such as airports, theme parks, tourist, or administrative centres. Development in the station vicinity was also uneven, with some stations such as Stratford, Massy, Chessy, and Guadalajara enjoying significant development, while others such as Ebbsfleet, Toledo, or Segovia experiencing no development so far. Despite the presence or absence of development on the ground, many municipalities have prepared plans for future development. Thus, an important finding is that HSR-induced population growth and employment is not exclusively related to any one of the six types of our taxonomy; other factors intervene and play a role. These are as follows.

#### 6.1. Distance of Ex-metropolitan Station from the Metropolitan Centre and Type of HSR Connections to Help Metropolitan Subcentres

The distance between ex-metropolitan stations and metropolitan centres is likely to affect the type of station area development. Apart from those stations located near major activities, projects, or transportation nodes (Euro Disney, Charles-de-Gaulle airport, and Stratford-Olympics), a moderate distance (20–35 km) combined with good metropolitan transport connections increases the possibilities of generating metropolitan subcentres (station types II and III in our taxonomy). Thus, the Paris ex-metropolitan stations that are all 20–35 km from the centre of Paris and connected to the metropolitan conventional rail have become employment centres. The most relevant case is Massy that, even without
the advantage of a major attraction nearby, has attracted significant station area develop-
ment, thanks to its excellent connections to other metropolitan and long-distance transpor-
tation modes (metropolitan rail, airport, and motorways) and abundant long-distance HSR
services to most national destinations (tangential HSR type of connection).

Relocation of office activities to ex-metropolitan stations/cities is more difficult when
the placement of the HSR station in the metropolitan area is discontinuous, with distances
from the centre that are over 50 km) (station types I, V, and VI). This is evident in Ashford
and Segovia that have yet to see development around their stations, and Guadalajara,
where only residential development has appeared in the station vicinity. Therefore,
plans for the vicinity of the proposed ex-metropolitan HSR stations should take into
account the distance of the station from the metropolitan centre in projecting the type
of land uses that can be supported by the market.

Additionally, the type of mass transport connection that a station has is important. Thus,
ex-metropolitan stations that connect to several long-distance destinations are more efficient
in helping the creation of metropolitan subcentres (e.g. the Paris ex-metropolitan stations on
tangential line) than those that connect only to a few destinations (e.g. Ashford and Guada-
lajara on a radial line and a low percentage of long-distance riders).

6.2. Intermodality

The case studies confirm that good connections with other transportation modes can
help increase the HSR ridership and attract more station area development. The three
ex-metropolitan stations of Paris are all combined with metropolitan conventional
stations and motorways. One of them is at an airport, while another is by a leisure
theme park. The three ex-metropolitan London stations are also well connected to
the conventional rail and metro services. On the other hand, the Madrid ex-metropolitan
stations are not connected to conventional rail and have significantly fewer passengers
than their London and Paris counterparts. It is, therefore, important for ex-metropolitan
stations to be located in areas that are well integrated with other transportation
networks.

6.3. Availability of Developable Land

As already discussed, urban development tends to happen, if planned for, in stations close
to the metropolis (types II and III). However, it may also happen in more distant stations
that have peripheral station locations (Station type I: Guadalajara and Segovia) and an
abundance of undeveloped and relatively affordable land in their surroundings. Urban
development happens to a lesser degree in more distant central/edge stations, where the
amount of available land for future developments is limited or constrained by other
natural or artificial barriers (Ashford and Toledo). Level tracks complicate urban coher-
ence (e.g. Ebbsfleet), while underground ones (e.g. Stratford) seem to avoid the presence
of the barrier effect between the station and its surroundings.

6.4. Station Location

Station locations close to a city’s centre have the advantage of being better integrated to
the rest of the urban fabric, are typically better connected to other modes of transport, and
offer passengers the opportunity to walk from the station to a number of destinations. Per-
ipheral stations often lack good connectivity, which may provide a disincentive for deve-
lopment in their vicinity. On the other hand, they may have the advantage of cheap and
abundant developable land in their vicinity. Ebbsfleet and Segovia stations are in periph-
eral locations and have not observed new developments in their immediate vicinity, while
Guadalajara has initiated development but has been affected by the building crisis. The
Toledo station, built near the historic centre, has also not witnessed any new development,
but its proximity to the city’s historic locations has helped increase the HSR ridership by
tourists.

6.5. Importance of Station’s Other Assets

The mere introduction of a new ex-metropolitan HSR station can rarely catalyse further
growth and development unless it is strategically complemented by other assets. Thus,
the development of research and university complexes at Massy, the Euro Disney
theme park at Chessy, and the Charles-de-Gaulle airport at Roissy have greatly increased
the ridership of the HSR station and developed the surrounding areas into subcentres. The
HSR was also able to further boost pre-existing tourist and university industries in Toledo.
In contrast, the HSR has not induced station area development in the low-density, semi-
rural area of Ashford. Therefore, it is important that ex-metropolitan cities that host
new HSR stations consider how they can better use the introduction of the HSR to comp-
lement and further boost their existing assets.

6.6. Importance of Plans

Most of the ex-metropolitan stations studied have witnessed a significant level of pre/post-
planning by municipal authorities as well as some private developers. The plans for the
three ex-metropolitan stations around London, the Atlantis master plan at Massy, Val
d’Europe at Chessy, Ciudad Valdeluz in Guadalajara, and the Segovia corridor and
business park, have been only partly realized. Nevertheless, they represent important
visions for long-term future development in station areas.

6.7. Appropriate Number of Ex-metropolitan Stations

This study has not been able to assess the appropriate number of ex-metropolitan stations.
However, we suspect that the overall size and population density and distribution of a
metropolitan area together with the type of HSR network (radial versus orbital) and the
expected number of long-distance services should guide the number of ex-metropolitan
stations. Long-distance HSR services need as few stops as possible between origin and
destination to be efficient and compete with air transport. If the number of ex-metropolitan
stations increases, fewer trains may stop at each station. Currently, London–Continent
HSR trains do not stop at Stratford; 17% stop at Ashford; and 33% stop at Ebbsfleet.
Just about half of the long-distance London–Continent HSR trains stop at ex-metropolitan
stations, and another half do not stop at any ex-metropolitan station. As observed in the
case studies, there seems to be a positive relationship between the numbers of trains stop-
ing at an ex-metropolitan station and the level of new development, but more research is
necessary to establish this confidently.
In conclusion, policy-makers and planners of new stations and HSR systems should carefully consider the various factors that have an effect on the territorial and local impacts of HSR stations. As it was clear from our taxonomy, the ex-metropolitan stations studied have different locational and transportation characteristics. For this reason, the observed urban development effects of the HSR and the extent of achieved metropolitan integration and subcentre development is not homogenous but rather influenced by the interplay of different factors, which are not always easily isolated from other forces. In this regards, we may characterize HSR’s effect on economic and urban development as analogous to a fertilizer’s effect on crop growth: it is one ingredient that could stimulate development of ex-metropolitan stations and better integration to the metropolitan area but other important ingredients must also be present.

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Notes

1. HSR allows commuting along further distances, up to 200 km (i.e. the cases of Ciudad Real in Spain or Vendôme in France) and thus certain metropolitan integration; but at this distance, most places do not have HSR and thus are not part of the metropolitan regions, only a few places with HSR are part of them. Even in the later, the usage of HSR decreases very rapidly with the distance to the HSR station; in the case of Ciudad Real, it remains significant only for about 15–25 km (Menéndez et al. 2002; Ureña et al. 2005).
2. Both stations are connected since 2011 by the Docklands Light Railway (DLR).
3. Mixed services are those that combine HSR and conventional ones during the same journey.
4. The plans foresee 10,000 new homes and around 5.6 million m² commercial/office space, together with retail and other supporting uses.
5. There is no train connection between the two stations.
6. The linear new town of Marne-la-Vallée, east of Paris, was planned as a high-quality residential area. It houses the Noisy-le-Grand office and university area, which is the third largest office employment area of Paris, and the Cité Descartes University and research pole.
7. Including one direct service to London.
8. This area has a total of 1600 new apartments, 12,000 m² of office space, 5670 m² of shops and services, and 8,000 m² of other facilities.
9. Roissypôle is the name of the Charles-de-Gaulle airport complex of hotels, office buildings, train, and bus stations.
10. We call local buses those services only within the municipality where the HSR station is located.

References


Road accessibility and articulation of metropolitan spatial structures: the case of Madrid (Spain)

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A B S T R A C T

In the last few decades, rapid growth in mobility has facilitated the inclusion of distant places in metropolitan processes and the modification of traditional metropolitan areas into Polycentric Urban Regions. This paper aims to understand the articulation of metropolitan urban regions through a diachronic road network accessibility analysis with a focus on the Madrid Metropolitan Region (Spain) over a period of general increase in accessibility. The findings reveal that the metropolitan core has been reinforced and that its influence area has expanded. However, the main contribution of this work is the proposal of a methodological approach to identify city-profiles among the sub-centres organising the emerging polycentric urban structures.

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1. Introduction

Changes in urban systems have occurred in recent decades at different spatial levels (Anas et al., 1998; van der Laan, 1998). Aiming to identify the features of emerging urban forms and the driving forces of these spatial changes, many scholars have already studied the transformation of metropolitan areas from monocentric to polycentric (Lee, 2007).

Although these metropolitan changes vary among regions in developed economies, in the last few decades, the general trends can be summarised by an increase in their catchment area, covering a wider territory, and a re-location of population and economic activities within the metropolitan boundaries, generating poly-nuclear urban structures (see Fig. 1).

From a spatial perspective, the debate regarding the evolution of metropolitan regions is closely related to transport developments (Helbich and Leitner, 2009) especially roads and highway systems (Baum-Snow, 2007). This undeniable relationship between transport and metropolitan change has been extensively studied from many points of view: (a) the scale shift and enhancement of externality, progressively integrating wider areas; (b) the settlement structure transformation, with phenomena like urban sprawl and re-location of economic activities; (c) the evolution of the internal functional relations, mainly derived from the increasing interaction within urban networks; (d) the new economic patterns resulting from specialisation and complementary processes; and (e) the application of more rational principles for land-use planning and decision-making (governance).

In this context, the relationship between urban structures, transport networks and accessibility has been positioned at the heart of different discourses about growth, cohesion, sustainability (EC, 1999; Gordon and Richardson, 1996; Scott et al., 2001; Horner, 2004; Sohn, 2005), decentralisation and core-periphery relations (Meijers et al., 2012). Moreover, accessibility has been used as a tool for exploring and describing complex metropolitan structures (Giuliano et al., 2012) that rely on the identification of employment sub-centres, as originally proposed by Giuliano and Small (1993).

In addition, other empirical approaches have used flow analyses to unravel polycentric structures (Clark and Kuijpers-Linde, 1994; van der Laan, 1998; Limtanakool et al., 2007).

However, whilst transport networks are better characterised as facilitators, a complex set of economic and urban factors are causing or fostering these structural transformations. From a social perspective, transport allows increasing commuting and migration levels and facilitates population and economic growth by raising the opportunities for spatial contact (Anas et al., 1998; Kloosterman and Musterd, 2001; Schwanen et al., 2001).
Fig. 1. Theoretical scope.

social aspects such as the share of part-time jobs, car use or transportation cost levels (Zheng, 1991; Le Néchet, 2012) also highlight the role of transport. Similarly, different economic factors have been identified, in advanced economies, as the causes of metropolitan evolution, such as changes in the structure of economic activities (i.e., concentration or specialisation patterns), in the production structure and location, or in the share of economic activities (influenced by the spread of the use of ICT and the increasing importance of services and knowledge sectors) (Fujita and Ogawa, 1982; Krugman and Venables, 1996; Bogart and Ferry, 1999; Lee, 2007; Garcia-López and Muñiz, 2010).

Nevertheless, the work presented in this paper does not intend to examine the driving forces that give rise to new metropolitan structures but to understand the influence of road networks in facilitating metropolitan processes. More specifically, focused on a morphological analysis, the aim of this paper is to determine to what extent road accessibility analyses are appropriate in describing changes in metropolitan spatial structure (Giuliano et al., 2012).

The analysis carried out in this paper is developed for the Madrid Urban Region which has rapidly developed from a compact urban pattern towards a more sprawling one, showing an expansion process in the last few decades (del Cin et al., 1994). This spatial growth can be contextualised and analysed together with its transport network growth, included in the 1984–2008 Spanish transport policy. Hence, since the late 1970s Madrid evolved from a centralised metropolitan area towards a polycentric metropolitan region (Heitkamp, 2000). The two time scenarios of 1981 and 2011 are chosen according to the corresponding Census data. Despite the fact that public transport plays a crucial role within the traditional metropolitan area (up to 40–50 km from the metropolis), this study focuses only on the road network. This is because the share of private car in medium-distance travel (over 50 km) was 78% in 2007 (Fomento, 2007).

The paper is set out as follows: Section 2 builds on the theoretical approach, connecting spatial accessibility analyses and recent transformations of urban systems. This is followed by the proposed methodology in Section 3, which describes the proposed accessibility model. Section 4 defines and characterises the case study; followed by Section 5 which gathers the main results and outcomes. The last section summarises and discusses the research conclusions.

2. Theoretical background: accessibility and polycentric urban structures

The relationship between transport, accessibility and metropolitan spatial structure has acquired major relevance in literature and has been treated in different ways. This section proposes a perspective for exploring the influence of road accessibility in the urban system, fostering the gradual transformation of monocentric metropolitan areas.

2.1. The analysis of Polycentric Urban Regions

Polycentric patterns in urban systems have been recognised in different ways, and the notion of polycentrism has become polysemous, assuming mutual interaction as a key element (Green, 2007).
These polycentric urban networks can be identified at two different scales: (a) intra-metropolitan polycentrism, as a result of the generation of new centres (Garreau, 1991; Richardson, 1988) and the reinforcement of the industrial poles of the first industrialisation process (Roca et al., 2012); and (b) supra-metropolitan polycentrism, as a result of the integration of new metropolitan regions, whether by coalescence of spaces in different provinces/regions, as in the Randstad (Netherlands) or Rhine-Rhur (Germany) (Hall and Pain, 2006; Kloostrerman and Musterd, 2001; Meijers and Romein, 2003), or by the extension of the metropolitan influence over close systems of small and medium-sized cities (Roca et al., 2012; Solís et al., 2014).

Two main approaches have been used to measure urban polycentrism: morphological and functional. The morphological approach is based on identifying nodes and characterising them in terms of size and complementarities to other nodes (see the seminal work by Giuliano and Small, 1993). The functional approach is based on characterising centres by their interconnecting flows. Different types of flow are used, such as daily commuting, business and leisure travel and also intra-metropolitan migration (Limtanakool et al., 2009). This paper uses the morphological approach, setting out the appropriateness of accessibility as a proxy to interpret the urban network and the potential for spatial integration (Fig. 1).

Improvements in transport systems (infrastructure and services) have relevant implications for spatial structures and functional relationships. First, better communication systems diminish time distances, bringing distant territories closer together (a phenomenon known as time-space convergence, (Spiekermann and Wegener, 1994)), and expanding potential catchment areas (spreading effects). The general increase in individual mobility over the last decades has allowed an important scale shift, integrating larger areas and extending the concept of Functional Urban Areas (FUAs) to that of Polycentric Integration Areas (PIAs) (ESPON, 2004). Second, economic activities decentralisation and residential dispersion, supported by new transport networks, may lead to the appearance of new centres in metropolitan peripheral locations, taking advantage of high accessibility levels, closeeness to the centre and lower land prices. Both aspects, expansion and new relations within metropolitan regions, suggest the emergence of polycentric spatial structures. However, in formal terms, functionality and integration show that centrality still matters and that interaction is beyond morphological aspects, as van Oort et al. (2010) proved in the Randstad. Taking this into consideration, there are three main questions connecting metropolitan spatial structure and road system:

(a) **Integration**: Road network improvements facilitate a scale shift in the settlement system, increasing the daily reachable spaces and nuclei. Hence, what is the spatial extent of the metropolitan centre and sub-centres influences?

(b) **Interaction**: Road transport reinforces agglomeration economies and makes possible the urban economies of proximity (this can also be interpreted as a measure of centrality). Therefore, what is the potential of mutual interaction within extensive metropolitan areas?

(c) **City-profile**: Accessibility improvements help cities to acquire competitive advantages and define potential locations for workers and/or jobs. Thus, are these changes in extension and interaction affecting the main roles of metropolitan centres? And, how are the sub-centres participating of the subsequent structure?

2.2. The accessibility analysis of urban networks

Accessibility is often used to explore metropolitan relations and urban networks. In this context, accessibility has been used as a reliable empirical concept to relate urban structures and jobs/housing locations (Horner, 2004). Progressively, longer commuting distances allow greater separation between housing and workplaces, giving way to the spreading effect and triggering other related effects that allow the appearance of nearby sub-centres (Solís et al., 2012). As a result, contrary to the traditional mobility patterns of movements directed from the periphery to the centre, mobility has become more heterogeneous and polynodal, including flows from periphery to periphery and from centre to periphery (van der Laan, 1998).

Moreover, road network improvements have allowed a scale shift of the traditional metropolitan area, extending its boundaries (Baum-Snow, 2007; Rodrigue et al., 2009; García-López, 2012), catalysing agglomeration and modifying inter-city relations as a consequence of new functional linkages among peripheral metropolitan municipalities. Accessibility measures are a component of numerous urban studies looking at the spatial organisation of urban systems (Harris, 2001): they have been applied to visualise aspects of urban morphology and location in economic systems (Cheng et al., 2013) and urban flows distribution (Paturelli et al., 2007; Reggiani et al., 2011). In any case, the key factor that enables the use of accessibility at the urban level is its ability to visualise and analyse spatial processes.

One of the earliest measures applied to recognise urban spatial features is the cumulative opportunity or contour measure (Ingram, 1971; Vickerman, 1974). The contour measure can be used to define catchment areas by determining their limits within certain travel times or distances from a node, assessing the number of opportunities that can be reached within each time or distance threshold.

Among the existing literature, studies considering accessibility as a facilitator for spatial interaction are relatively frequent (Hansen, 1959; Wilson, 1967; Morris et al., 1979). Several studies have focused on potential accessibility measures, which have been profusely used to depict and describe spatial configurations. Recent examples highlight their usefulness to acknowledge the influence of accessibility in shaping urban networks (Cheng et al., 2013) and relations through different approaches such as commuting flows in extensive urban areas (Sohn, 2005; van Oort et al., 2010), or the market potential of workplaces and labour with a regional scope (López et al., 2008; Condeço-Melhorado et al., 2011).

In some cases, these models achieve great complexity, assuming a certain capability to embed heterogeneous components (van Wee et al., 2001). Several authors have adapted potential accessibility measures to include competition effects which affect spatial modelling and location patterns (Eiselt and Laporte, 1989), distorting the results of potential measures. For example, Joseph and Bantock (1982) analyse accessibility where competition only takes place in destinations. Others ground competition in origins by dividing the available opportunities at origin i by the potential demand from i (Weibull, 1976; van Wee et al., 2001). A third group considers competition at both origins and destinations based on the balancing factors of Wilson's double constrained spatial interaction model (Horner, 2004; Paturelli et al., 2007).

3. The empirical model: assessing accessibility patterns

The methodology proposed in this paper is based on a combination of complementary road network accessibility indicators for two time scenarios (1981 and 2011). The method is built for a better understanding of the spatial structure and dynamics of urban regions, given the capability of accessibility to embed spatial structures and their relationship with urban networks at several scales (Geurs and van Wee, 2004; Horner, 2004). This approach combines
three different indicators to acknowledge different components of the metropolitan spatial structure (Fig. 1 and Table 1).

The reason why three combined accessibility measures are used is twofold:

- First, since there is a specific interpretation for each measure, related to aspects of the metropolitan region spatial structure (vertical reading, see Fig. 1): (a) the extension and growth of the urban interaction area is measured by a contour indicator; (b) the potential for interaction within the urban region is described by a potential indicator; and (c) the role and performance of sub-centres in polycentric metropolitan regions is evaluated by a competition indicator.
- Second, the three aforementioned steps are actually a sequence, because the output of each measure becomes the input of the subsequent one, delimitating the area to which each measure is applied (horizontal link among measures). The results of the contour indicator are the sample involved in the analysis of potential accessibility, and the main centres organising the metropolitan regions identified by applying this second indicator are further analysed by the competition one. This means that the latter indicators partially include results of the previous analyses (horizontal reading, see Fig. 1).

The model is set in a GIS geodatabase including information of municipalities and roads, and fed by two data sources, both at municipal level: (a) number of available jobs from Social Security sources (obtained under request), and (b) number of workers from the Spanish Official Statistics Institute (INE) website.

Travel time is calculated by computing the road network in GIS. In order to do this, four road types are identified (motorway, conventional road, urban artery and city street), assigning to each one a maximum speed according to the existing standard at each time scenario: 1981 (100, 70, 40 and 30 km/h) and 2011 (adding 10 km/h more). In addition, each road stretch is qualified in order to model this maximum speed to capture congestion at specific stretches: (a) 80% speed reduction at road crossings, (b) 30 km/h along local streets connecting each city with the road network, and (c) estimated speed based on congestion levels in some metropolitan roads (as assessed by Abadia and Pineda, 2009: 17).

Once the GIS database is built, the model is able to produce results following the sequence of accessibility measures that are intended to explore successive urban network components (Table 1).

### 3.1. The contour measure

The contour measure provides evidence of the spatial scale expansion of urban regions over the years by the increasing number of municipalities, people and jobs that can be reached within certain time budgets.

This contour measure is formulated (Eq. (1) in Table 1) as an expression depending on a Boolean function (being 1 if zone \( j \) is within the time threshold and 0 otherwise) and on the number of opportunities in zone \( j \). The wide variety of travel time budgets considered in the literature demonstrates the difficulty of establishing a unique value which greatly varies from country to country (Cerdá, 2009; Kawabata, 2009; Curtis and Scheurer, 2010; Reggiani et al., 2011). Nevertheless, an ESPON (European Spatial Planning Observation Network) report delimitates FUAs throughout the European Union considering the reachable area from each centre by car, based on the hypothesis that commuting flows occur predominantly within a 45 min time budget (ESPON, 2004).

While this indicator incorporates land use patterns and infrastructure constraints and is easy to interpret, it has some theoretical shortcomings. First, the results greatly vary depending on the time budget considered. Second, it does not account for the size of the facilities (attractiveness) or the cost of reaching them. Finally, it does not take into account a distance-decay function to weight the opportunities. For these reasons, the area delimited by a travel time budget value should only be considered as a potential interaction catchment area. Two thresholds are used in this paper: 45 min to define the external contour of the metropolitan region, and 30 min to define proximity effects more accurately.

Results are useful in two ways: (1) they define the area in terms of proximity and probability, plotting the maximum extent of each FUA and setting the final sample of municipalities within the given time distance in the 2011 scenario (the maximum possible sample); and (2) they allow defining inner/smaller time threshold contours to characterise different interaction probabilities and proximity ranges.

### Table 1

Summary of the accessibility analysis sequence followed in the empirical application.

<table>
<thead>
<tr>
<th>Component</th>
<th>Indicator</th>
<th>Formulation</th>
<th>Variables</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration</td>
<td>Contour measure</td>
<td>( A_i = \sum_{j=1}^{J} B_j \cdot O_j ) (1)</td>
<td>( t ): threshold/time budget</td>
<td>- GIS road network</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( B_j = 1 ) if zone ( j ) is within the predetermined threshold ( t )</td>
<td>( O_j ): opportunities in zone ( j ) (population and jobs)</td>
<td>- Population register, 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0, otherwise</td>
<td>- Workplaces, 2011</td>
<td></td>
</tr>
<tr>
<td>Centrality interaction</td>
<td>Potential measure</td>
<td>( A_{i,j} = \sum_{j} P_j \cdot f(d_{i,j}) ) (2)</td>
<td>( P_j ): jobs located in destination</td>
<td>- Workplaces, 1981</td>
</tr>
<tr>
<td></td>
<td>Impedance function:</td>
<td>( f(d_{i,j}) = e^{-\beta d_{i,j}} ) (3)</td>
<td>( \beta ): parameter</td>
<td>- GIS road network</td>
</tr>
<tr>
<td>Trends</td>
<td>Competition measure</td>
<td>( A_i \left[ \sum_{j} E_{i,j} / B_j \cdot f(d_{i,j}) \right]^{-1} ) (4)</td>
<td>( A_i, B_j ): accessibility indexes</td>
<td>- Population registers, 1981 and 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>( B_j \left[ \sum_{i} E_{i,j} / B_j \cdot f(d_{i,j}) \right]^{-1} ) (5)</td>
<td>( E_{i,j} ): attraction factor of zone ( i ) for trips originated in zone ( j ) (number of jobs)</td>
<td>- Workplaces, 1981 and 2010</td>
</tr>
</tbody>
</table>

(2) Geurs and van Wee (2004: 133).
(3) Reggiani et al. (2011: 532).
(4) and (5) Willigers et al. (2003: 9).
3.2. The potential accessibility in urban networks

Once the extension of the metropolitan region has been defined, the second step applies the potential accessibility measure to the resultant sample. The potential accessibility expression used in this paper considers two factors (Eq. (2) in Table 1): attraction caused by available jobs and friction of distance by travel time incorporated as a power-decay function. Results show that each location \( i \) interacts with other locations \( j \) due to the local labour market attraction. Besides, this measure allows the evaluation of centrality since the resulting hierarchy shows the relative attractiveness of each location.

The use of such indicators is revealed as the best possible combination of accuracy and efficiency in terms of data requirements and result readability (Geurs and van Wee, 2004). However, the main limitation of potential accessibility measures is that they do not consider competition effects and temporal constraints. Moreover, their use implies that the demand for opportunities is uniformly distributed across space and/or that these opportunities have no capacity limitations (Cerdá, 2009).

This second step aims to analyse potential accessibility changes between 1981 and 2011. However, the use of two different time scenarios generates an endogeneity problem derived from the causal relation between transport improvements and population growth. In this sense, it is almost impossible to determine whether the accessibility gain is due to the first or the latter factor (López et al., 2008). A possible solution is making one variable time-invariant, avoiding causality between variables (Baum-Snow, 2007; García-López, 2012). In our analysis, jobs are fixed to the situation in 1981 in Eq. (2) (Table 1) and travel time varies for both network-scenarios (1981 and 2011) to partially address this shortcoming.

This procedure assesses the road infrastructure role in the distribution of accessibility beyond location changes and population growth. Nevertheless, in order to add a perspective on population and its changes, the paper also proposes a typology of municipalities according to the evolution on potential accessibility and demographic change between 1981 and 2011.

3.3. The evaluation of competition

Lastly, competition is included: first, to address the problem of gravity models in samples where locations can serve as both time origins and destinations, and second, to add a new insight to the previous interpretation, by characterising (only) the best-performing poles (metropolitan sub-centres) in the potential accessibility measure, since they have the highest potential roles in organising metropolitan regions.

This paper accounts for such competition effects based on the balancing factors of Wilson’s double constrained spatial interaction model, bearing in mind that competition exists both at origins and destinations. The most important advantage of this model is precisely this two-way consideration, providing more realistic accessibility estimations. However, its main disadvantage is the difficulty for estimation, interpretation and communication (Geurs and Ritsema van Eck, 2001). Therefore, this approach facilitates the description of each zone with two accessibility values, understood as the effort (for residents/potential employees of each zone) to access (the jobs of) the rest of the sample \( (A_i) \) and the ease (of the jobs) for being accessed by the potential workers of the whole sample \( (B_j) \).

This measure is formulated as two mutually dependent expressions (Eqs. (4) and (5); Table 1) which have to be obtained iteratively until the model reaches equilibrium. Moreover, the first indicator \( (A_i) \) is directly dependent on an attraction factor \( (E_j) \) of zone \( j \) for trips generated at zone \( i \) and the second one \( (B_j) \) is directly proportional to a repulsion factor \( (O_i) \) of zone \( i \) for trips with destinations in this zone. Similarly to the potential accessibility measure, the two expressions are dependent on an impedance function, \( f(d_{ij}) \) (Willigers et al., 2003).

The aim of this measure is to provide an accurate characterisation of the main centres organising the metropolitan region since each sub-centre has followed different trajectories giving rise to different city-profiles among Polycentric Urban Regions. In this manner, the current urban structure is a result of an interdependent relationship between transport (road) network improvements and residences/workplaces locations (that is to say, road improvements may influence population/jobs relocations but also an increase of jobs or population in a given location may lead to road improvements due to increased travel demand). Therefore, the competition measure formulation takes into account the variation of both travel cost and attraction factors for each time scenario in order to better capture the urban network complexity.

4. Study area

The accessibility model is applied to the Madrid Urban Region over the last three decades. During this period, both a regional urban spatial reconfiguration and a noteworthy road network change took place (Fig. 2). This change was caused first, by the transformation of radial roads into motorways and duplicating radial motorways in several corridors (northeast, southeast, south and southwest). Second, by the creation of two orbital motorways (M-30 and M-40) around and close to Madrid and also two semi-orbital ones (M-45 and M-50) along the west-south-northeast sectors and slightly further away from the centre (5–10 km the first two and 10–15 km the latter). Lastly, by the creation of a tangential motorway from Toledo towards the southeast (CM-42). The resulting transport network morphology allows primarily radial relations with the centre and secondarily tangential connections.

Gutiérrez and Gómez (1999) applied a potential accessibility analysis to the new orbital motorways around Madrid and predicted a tangential effect because they had created one of the densest radio-concentric networks in Spain. Their conclusions started to plot the forthcoming meshing of the road network and progressive integration of the urban network. At a national scale, Holl (2007) evaluated accessibility improvements due to the 1980–2000 Spanish motorway programme, showing how the main centre (Madrid) had concentrated accessibility and how considerable improvement occurred along all radial corridors.

Within this context, Madrid evolved towards an urban region with some daily functional relationships with the adjacent provinces of Guadalajara, Toledo and Segovia. The initial study area is set as the centre of the Madrid Urban Region and the three capital cities of the aforementioned contiguous provinces (Guadalajara, Segovia and Toledo).

Solís et al. (2014) stated that the emerging Madrid polycentric situation can be encapsulated as a network of medium-sized cities around Madrid (Fig. 2). This heterogeneous area is composed by numerous municipalities that take part in the whole system with different characteristics and integration levels.

5. Results

The results achieved can be summarised on three aspects. First, in terms of extension, the growth of the metropolitan region, overflowing beyond its traditional boundaries and reaching historic administrative cities. Second, in terms of urban structure, the change from a monocentric model towards a polycentric/dispersed one. Finally, in terms of urban system complexity, where each metropolitan sub-centre acquires different profiles.
5.1. The urban network: inclusion and extension

The scale shift experienced by the metropolitan area is tackled by a contour measure, using 30 and 45 min travel time thresholds from Madrid and the respective capitals of the adjacent provinces of Guadalajara, Segovia and Toledo (Fig. 3). As it could be expected, the reachable surfaces have increased and they considerably overlapped in 2011, especially those centred
in Madrid, Toledo and Guadalajara (Fig. 3e). In 1981 the area accessible in 45 min from the centre of Madrid overflowed towards a small number of municipalities of the Toledo and Guadalajara adjacent provinces, not reaching their capitals. The accessible areas
from the centre of each provincial capital included parts of the Madrid administrative region/province, but none reached any other capital. In 2011, the wider territory accessible in 45 min from the centre of Madrid, reached the cities of Guadalajara and Toledo, and the same happened in reverse. However, none of the 45 min accessible areas centred in the three provincial capitals reached either of the other two. In 1981, only the 30 min accessible areas from the Madrid and Guadalajara centres slightly overlapped, while in 2011 they overlapped much more, as well as those from Madrid and Toledo (Fig. 3e).

The spatial shape of these enlargements demonstrates a core-periphery pattern, growing in all directions from Madrid and asymmetrically from the other centres (Fig. 3d). The areas centred in Guadalajara and Toledo grew more towards Madrid (Fig. 3a and c), while in the case of Segovia (Fig. 3b) the growth towards Madrid in Guadalajara and Toledo grew more towards Madrid (Fig. 3a and b). The same happened in reverse. However, none of the 45 min accessible areas centred in the three provincial capitals reached either of the other two. In 1981, only the 30 min accessible areas from the Madrid and Guadalajara centres slightly overlapped, while in 2011 they overlapped much more, as well as those from Madrid and Toledo (Fig. 3e).

Table 2 shows this spatial growth in terms of population and jobs within the thresholds. Madrid experienced a great increase in the number of habitants and jobs being accessible in the shorter (30 min) threshold because large adjacent municipalities grew closer, while Guadalajara and Toledo improved more in the longer (45 min) threshold due to the new found proximity to the larger municipalities. Segovia does not show much improvement in comparison to the others.

This means that Madrid better improves the population’s access to jobs 30 min away when compared to the other three cities mentioned above; that Madrid, Guadalajara, Toledo and their intermediate areas increase their chances of becoming interweaved (reached from two cities); and that Madrid and its eastern and southern surrounding municipalities have the greatest potential of being reached from three cities.

5.2. Measuring the potential for attraction and interaction

The potential indicator shows a general increase of accessibility (Table 3). It is noticeable that the dispersion value increases during the study period and that the spatial correlation value increase is even greater (Moran’s i results). This demonstrates that accessibility improvements tend to concentrate in a few municipalities and are not generalised throughout the sample.

Locations with the highest potential accessibility levels are spatially clustered around the metropolitan centre in both scenarios, which is consistent with previous analyses (Gutiérrez and Gómez, 1999; Holl, 2007). The year 2011 shows a more spread pattern than in 1981, but also concentrated from/to the centre, strengthening the advantages of central locations and reinforcing the lack of potential accessibility of the peripheral locations (Fig. 4a).

In 1981, locations sharing higher accessibility values were clustered in the first belt around Madrid, which may be interpreted as a limited number of places taking part in the metropolitan processes. The corridors of transport were taking shape at this time and there was only a southwesterly cluster of sub-centres. In 2011 the situation was similar, but the number of sub-centres involved had slightly increased. Nevertheless, the northern corridors did not improve as much as the southern ones, probably because the development of new infrastructure started later on and was less dense than towards the south. In other words, in 2011 the lead taken by the southern belt was more visible.

Relative variation of accessibility (Fig. 4b) shows a spatial pattern of winning areas, which tend to be located in a periphery near the centre (Madrid), and polarising corridors southwards along the new radial axes. It also appears that a rough spread of accessibility increase follows some tangential motorways connecting the main radial ones.

The peripheral provincial capitals show different patterns, despite their similar distances to the metropolitan centre. It is also remarkable to point out that the limits set by the contour measure include distant places that show little capacity for interaction, demonstrating that the contour analysis probably overestimates the actual extension of the metropolitan influence and that the speed limits overestimates the actual range of distance covered by calculated travel times.

Once endogeneity has been partially addressed by fixing the number of jobs (as in 1981), population changes are also included in the analysis. Combining both accessibility and population evolutions, a three-typology classification is proposed (Fig. 4c): (a) leading poles as those municipalities that considerably gained in potential accessibility and population, (b) growing areas as those gaining considerably in potential accessibility but with comparatively smaller growth in population, and (c) areas without growth as those that did not gain considerably in either aspect.

In conclusion, a clear pattern can be identified, with leading poles located around Madrid (the most powerful ones within 25–30 km of Madrid) and along some radial corridors, reaching and including only the capitals of Guadalajara and Toledo (not...
Segovia. It is noteworthy that the hereby identified leading poles are the same as the ones concluded by other scholars who have considered other methods such as commuting linkages and employment or population concentrations (Gallego et al., 2010; Solís et al., 2012), demonstrating the validity of the hereby proposed accessibility approach in understanding urban patterns. The other two types of municipalities can also be interpreted according to their location and closeness to the metropolitan centre: the first belt (closer to Madrid) characterised by a predominance of growing areas, and those areas without growth located at the second belt, further away from the metropolis.

5.3. Competition and city-profile

Lastly, competition effects are assessed. The input sample for this measure is the set of municipalities classified as leading poles by the potential measure analysis (Section 5.2 and Fig. 4c), since they have the highest potential in organising the area and competing for opportunities with each other. The sample consists of 36 municipalities (only 6.5% of the previous sample), which include Madrid, and extends to two of the three capitals: Guadalajara and Toledo. The required iterative calculation to use the competition measure was undertaken between these 36 municipalities competing for inhabitants and workplaces of the rest of the leading poles.

The outcome of these calculations (Fig. 5) is used to rank these 36 leading poles in regards to their effort for reaching the rest of the sample (Fig. 5a) and vice versa (Fig. 5b). These results are used to assess changes in these rankings between 1981 and 2011 (Fig. 5a and b), and to define a typology of cities in terms of their capability for competing for workplaces and for potential workers (Fig. 6c).
In absolute terms, all the leading poles improved their ease for accessing the workplaces of the rest (between 1981 and 2011). Taking into account the 2011 scenario, three main patterns were identified (Fig. 5a):

- The first belt surrounding the metropolis had the greatest competition accessibility levels, especially those located in the southwest sector, favoured by the concentration of high-capacity infrastructures. These municipalities had the highest capabilities for accessing workplaces and competing for available jobs.
- The effort for residents to reach workplaces spread along the main radial corridors with its origin in Madrid.
- Regarding the two peripheral capital cities, both Toledo and Guadalajara reached the highest accessibility levels (as well as municipalities closer to Madrid). In relative terms, the municipality of Toledo improved its ease of access to available jobs and Guadalajara almost maintained it.

Similar outcomes can be drawn by analysing the ease of workplaces to be reached. Favoured by proximity, municipalities close to Madrid had the highest competition accessibility, and Guadalajara is the only peripheral provincial capital with a similar capability for attracting potential workers (Fig. 6b).

Each leading pole is ranked in regards to each competition accessibility measure and scenario, identifying which ones had a better, worse or equal competition accessibility ranking position in 2011 compared to 1981 (Fig. 6a and b). It is important to bear in mind that worse ranking positions do not mean lower accessibility levels in absolute terms, but a worse overall performance among the 36 leading poles in competing for available opportunities.
Consequently, this comparison allows identifying the following city-profiles among the sample (Fig. 6c):

- **Type A**: Optimal/Competing leading poles, which are characterised by a simultaneous comparative improvement of their attracting and emitting capabilities. These are municipalities that in 2011 had improved or maintained their ranking positions in reaching workplaces (Fig. 6a) and being reached by workers (Fig. 6b).

- **Type B**: Attracting leading poles which have reinforced their role as employment centres. These municipalities worsened their ranking positions in terms of the ease to reach workplaces (Fig. 6a) but maintained or improved them in terms of being reached by workers (Fig. 6b). The peripheral provincial capital cities are classified under this type.

- **Type C**: Emitting leading poles, which have reinforced their role as residential centres. They have worsened their ranking position in terms of capability to be reached by workers (Fig. 6b), but have maintained or improved it in terms of reaching workplaces of other municipalities (Fig. 6a).

- **Type D**: Losing leading poles, which have neither improved their role as residential nor as employment centres. They have worsened their results in terms of both reaching workplaces (Fig. 6a) and being reached by workers in other municipalities (Fig. 6b).

Finally, as it can be concluded from Fig. 6c, there is no spatial pattern in the distribution of these types of leading poles, which means that each centre has acquired its profile due to other circumstances (historic specialisation of the city, national investments in certain economic sectors, private developments, etc.)
and not merely due to its location. Moreover, the outcomes are consistent with previous studies describing the Madrid Metropolitan Region and its residential or employment centres (López, 1999; Solís et al., 2014).

6. Discussion and conclusions

This work reinforces the usefulness of accessibility in characterising urban systems that are evolving towards polycentric structures. Overall, transport and road improvements have greatly influenced the enlargement of catchment areas (leading to longer action radius of agglomeration economies) and the reinforcement of accessibility levels in central areas of metropolitan regions (together with a moderated spread along high-capacity corridors). These enlargements and reinforcements, together with an uneven population growth throughout the metropolitan region, have benefited the re-location of economic activities towards a limited number of sub-centres, giving rise to a polycentric urban model.

By providing a methodology based on a road network accessibility analysis, this research sheds light on characterising polycentric metropolitan regions and on differentiating city-profiles among the sub-centres organising these emerging urban structures. Particularly, the proposed combined methodology fosters a comprehensive approach focused on three spatial features of urban systems: integration, interaction and city-profile.

Firstly, metropolitan areas/regions are growing in extension (contour measure), integrating more distant territories and redefining the meaning of closeness (time-space convergence). The analysis of catchment areas also allows understanding the coalescence of labour and residence markets and the integration of distant historic administrative cities (provincial capitals).

Secondly, the capability for interaction (potential measure) demonstrates that some capital cities of adjacent provinces are acquiring similar leading roles than municipalities much closer to the central city, although they are far away from it. Hence, interaction and interdependence are not as closely attached to metric distance.

Thirdly, the competition for jobs and for workers (double-constrained competition measure) shows how certain places with relatively similar features adopt different profiles, specialising in attracting and/or emitting workers and thus reinforcing their role as employment and/or residential centres. This result is of an outstanding relevance since strong differences among leading poles can be perceived by using simple variables (travel time, total amount of workers and jobs). These simple variables can be easily mapped and interpreted to explore the configuration of metropolitan regions’ urban systems.

Lastly, while this paper focuses on the road network as a facilitator of metropolitan change, it is important to bear in mind that a complex set of economic and social factors clearly influences the emerging urban polycentric structures. Whilst this work focuses on the morphological approach of polycentrism, its results show a noteworthy level of coincidence with previous analyses using functional approaches (Gallo et al., 2010; Solís et al., 2012). Hence, the method may be considered as a suitable alternative and a reliable tool to recognise changes in the urban system when there are data constraints (e.g. lack of updated mobility/flow information).

In summary, this research confirms the usefulness of accessibility analysis in exploring and evaluating the morphology of urban regions, and in particular, in identifying different profiles among the sub-centres of new polycentric metropolitan regions. Although all these features have been demonstrated for the Madrid Urban Region, the method should be easily extendable to other metropolitan regions.

This research has not been able to differentiate between sectors and types of jobs and inhabitants. Including this further disaggregation would have provided useful additional insights into metropolitan changes, adding a sense of functionality in completion to the morphological approach. Future research should shed light on the above and also on the activities that may be undertaken from each centre within different time thresholds and catchment area scales.

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MOHINO, I., DELAPLACE, M. and UREÑA, J.M. (Mimeo) High-Speed Rail Networks and Station Surroundings Valorisation Policies: The case of Cities about 1 hour from Metropolises. Submitted to Belgeo (Accepted with major revisions).
High-Speed Rail Networks and Station Surroundings Valorisation Policies: The case of Cities about 1 hour from Metropolises

Abstract

The aim of this contribution is to analyse the interactions within metropolitan HSR networks, in regards to: a) their topology and the type of services at each station (radial connections to/from the metropolis and tangential ones between distant territories), and b) the valorisation policies at each type of station (central versus peripheral, in intermediate versus small cities, distance to metropolis, etc.). The paper focuses on cities smaller than 0.5 million inhabitants about 1 hour from the metropolitan centres of Madrid and Paris, and on the policies in each station surroundings. New findings are presented in relation to the valorisation of HSR station surroundings, arriving to more specific rules that include not only station location and city characteristics, but also the kind of HSR network. A typology of stations regarding the type of HSR network, valorisation policies and distance to the metropolitan centre is proposed.

Keywords

High-speed rail, metropolitan centre, radial services, tangential services, valorisation policies
1. INTRODUCTION AND METHODOLOGY

The interactions between transport network spatial configurations and urban structures are important. Transport networks shape the relations between territories, and the characteristics of territories and local policies conduce to specific valorisation of transport networks and services. Valorisation in the surroundings of HSR stations up to half an hour from metropolitan centres contradict some of the pre-existing general conclusions (Mohino et al., 2014).

HSR can facilitate territorial and local developments such as transformation of spatial/economic structures and station areas (Bellet et al., 2012), improvement of city’s position in the urban hierarchy, image (Urena et al., 2009; Delaplace et al., 2014) and tourism development (Bazin et al., 2014). Such impacts can vary (Loukaitou-Sideris et al., 2013; Delaplace, 2012) depending on the station-city: a) location in relation to other cities; b) economic features and trajectory; c) connectivity to transport corridors/nodes; d) type of HSR network and location in it; and e) station location within each city (Ureña et al., 2012).

At national/regional scales, HSR facilitates polarization between first- and second-tier cities (Garmendia et al., 2012b; Klein, 2004) and induces development in some small (Garmendia et al., 2012a; 2012b; Hall, 2009) and peripheral cities, because of improved accessibility/connectivity (Coto-Millán et al., 2007; Preston and Wall, 2008). HSR cities had greater employment growth than non-HSR cities (Haynes, 1997). However, some scholars only observe minor effects (Haynes, 1997) or only in a few kinds of urban areas (Bazin et al., 2013).

At the local scale, HSR is a catalyst for improving deteriorated city areas (Hall 2009) and for restructuring land uses around stations (Bellet et al., 2012) and has a significant impact on the distribution of jobs within their urban territory. HSR in some medium-size cities affects not only their station surroundings but also their overall structure (Ureña et al., 2009).

Local and regional economic developments have increased land values around some stations even in intermediate cities (Ahlfeldt, 2013; Banister and Berechman, 2000; Haynes, 1997). However, contradictory conclusions are also found, since Ahlfeldt (2012) doesn’t find any significant impact on real estate HSR neighbourhoods of certain cities. Others show that if there is a real estate dynamism at intermediate cities, prices don’t grow more than in their country and this growth happens only around the station (Bazin et al., 2010).

The mere HSR existence is not enough to improve economic dynamics (Meer et al., 2012; Bazin et al., 2013), although it provides important comparative advantages. European experience shows that municipalities must develop strategies to ensure HSR integration within the local economic and physical environment and to take advantage of new opportunities (Plassard, 1997; Bazin et al., 2006; Meer et al.,
2012; Van den Berg and Pol, 1998); strategies include planning, urban transport, management, and marketing measures (Van den Berg and Pol, 1998; Bellet et al., 2012; Bazin and al., 2013).

The HSR station locations are debated (Auphan, 2002; Mannone, 1997). Municipalities generate ‘activity parks’ for peripheral HSR stations to attract development, which in most cases has not happened, while a few are slowly successful (Facchinetti-Mannone, 2009), while central stations can better develop synergies (Bellet et al., 2012).

Literature shows heterogeneity concerning the link between HSR and local economic development (Delaplace, 2012). Additional spatial scales are necessary to understand the factors contributing to positive territorial developments (Loukaitou-Sideris et al., 2013). Some road studies include topological network analyses to determine accessibility differences, while they are not frequent for HSR networks (Urena et al., 2012a), although more needed since access points are less numerous.

The aim of this paper is to analyse the interactions within metropolitan HSR networks in regards to their topology and the kind of services and valorisation policies in each type of station in HSR cities (smaller than 0.5 million inhabitants) about 1 hour from metropolises. Madrid and Paris are considered, both with radial HSR lines, but with differences near the metropolises.

The data and indicators used to compare cities/stations are:

1.- Number of HSR radial and tangential services.
2.- HSR station location and surrounding policies/actions.
3.- City context and characteristics.

2. HSR NETWORK AND SERVICE CHARACTERISTICS: MADRID AND PARIS

2.1. HSR NETWORKS

Madrid and Paris HSR networks, up to 1 hour distance, are similar (Figure 1), with four radial lines, three developed up to 400-600 km, one/two still under development, and one/two that subdivide. There are 9 HSR stations/cities in Spain and 10 cities and 12 HSR stations in France (two cities have two stations). Both HSR networks have similar cities between 30 minutes and 60 minutes from the metropolis (Figure 1 and Table 3).

The differences happen close to the metropolises. Madrid has its nearest stations fairly distant (60-90 km), in areas influenced by metropolitan processes and discontinuously urbanized, while Paris has them much closer (20-35 km), within metropolitan and continuously urbanized areas (Figure 1 and Table 3).
The second difference happens at central stations (Figure 2). Madrid will soon have its two HSR central stations (Atocha and Chamartin) transformed to through stations along a HSR tunnel. Nevertheless, this tunnel will not connect all lines since the north-east line will not have access to it, thus will be terminus at the Atocha Station. The four Paris central stations are terminus.

The third difference happens at by-passes (Figure 2). Madrid has two short and partial by-passes which don’t have stations. Paris there has a long (91 km at 20-35 km distance) and complete by-pass with three stations, with HSR and metropolitan rail (RER); thus these stations are also Paris ones. Madrid only has/will have 2 through HSR central stations, while Paris has 4 terminus HSR central stations and 3 through HSR peripheral ones.

2.2. HSR NETWORK POTENTIAL SERVICES

The paper considers three types of HSR services according to the network geometrical/topological characteristics. Radial services are between each city and a metropolitan station; these normally exist and are demanded, with some being originated/destined at distant big cities/metropolises. Tangential services are between two cities different than the metropolises; they exist less and are less useful because they serve a smaller number of inhabitants/activities. There are two tangential sub-types, those along one radial line and those using two radial lines; the first ones happen more likely than the second ones. Mixed services are tangential that also call at the metropolis, and are more viable.
With the existing Paris and Madrid networks, including the tunnel between the two Madrid central stations, the potential HSR services are (see Figures 1, 2 and 3):

a) **Radial**
   - all can exist; nevertheless, in Paris some may call only at peripheral metropolitan stations.

b) **Tangential using one HSR line**
   - all but one can exist in Spain, with all lines having more than one city. The exception happens between Toledo and the two cities further south, Ciudad Real and Puertollano, which are not possible.
   - all but one can exist in France, although two lines only have one city. The exception happens along the south-west line that subdivides and relations are not possible between cities in each sub-line (Vêndome/LeMans and Tours/LeMans).

c) **Tangential using two HSR lines**
   - all but one can exist in Spain. The relations between the north-east line and the north line cannot take place. Those possible are more direct than the French ones (short by-passes or tunnel).
all can exist in France, although the by-pass can increase the travel time (10 minutes between Roissy and Chessy and 31 between Chessy and Massy), with connections between the north, east and south-east lines quite rapid, while those between any line and the south-west much longer.

d) **Mixed using one line**
- all tangential using one line potentially possible services can also be mixed.

e) **Mixed using two lines**
- only two can exist in Spain, while three cannot. The south/north and the east/north can exist along the tunnel, with the advantage of stopping at two central stations. Reversely, the south/east, south/north-east and east/north-east connections take place along by-passes without stations, thus cannot be mixed.
- all can exist in France, although they are only able to stop at peripheral metropolitan stations.

In Madrid the viability of two new stations to transform pure tangential services into mixed radial-tangential ones would increase their viability (see possible locations in Figure 2.a.). In Paris a direct tunnel connection between central stations would speed up tangential HSR services: between the two stations with more HSR passengers, Lyon and Nord, will not diminish substantially the connection length, while connecting those most distant along the by-pass, Montparnasse and Nord, would do so.

### 2.3. EXISTING AND POSSIBLE HSR SERVICES

Most existing HSR services are **Radial** and **Tangential Using One Line**. Nevertheless, in both cases, there are two Tangential Using One Line relations that don’t/will not exist because the network doesn’t allow them (section 2.2.). But their relevance is not comparable, since in France there are conventional rail alternative services (one hour travel time), while there are no ones in Spain (only bus services).

The number of Radial services varies similarly, 9 to 26 in Spain and 6 to 31 in France; the percentage in France of those using edge stations in cities and by-pass stations in Paris is low when total numbers are small, and high when numbers are high (Table 1). Reversely, the number of Tangential Using One Line services varies quite differently, 5 to 23 in Spain and 3 to 8 in France (Table 1). Nevertheless 60% of those between Ciudad Real and Puertollano and between Valladolid and Segovia are radial commuting regional HSR services that stop in both cities, and suppressing them the figures are comparable.

While in Spain all HSR services reach the same two central stations, in France only the three smaller cities, Haute-Picardie, Montbard and Vendôme, don’t have services calling at all Paris stations (Table 1).
There are more Tangential Using Two Lines services in France (7 out of 17) than in Spain (6 out of 30) and some have greater frequency (Table 1). This is because the tunnel connecting the two central Madrid stations is still not in operation, but also because all French services are mixed, while they are pure tangential in Spain.

In Spain from the 30 possible Tangential Using Two Lines relations, 4 are/will not be possible because the network doesn’t allow them. Reversely, 6 exist and 4 could exist easily since they will be mixed and serving also further distant cities. On top, 2 could exist less easily since they will be mixed not serving further distant cities and 4 could exist more difficulty because they are pure tangential but
serving further distant cities. Finally, 10 most probably won’t exist because they would require specific services and would not be mixed. Thus 46% will not exist, 33% will exist and 20% would be difficult (Table 1).

In France from the 17 possible Tangential Using Two Lines relations, all of them mixed ones, 7 take place, 2 could happen easily and 8 most probably won’t exist (see Table 1), this is to say 53% of possible services may exist. Thus, the percentage of envisaged Tangential Using Two Lines services would be slightly more probable and frequent in France.

There is no proportionality between the number of present HSR services and each city’s population (see Table 2), but there seems to be some in bigger cities of each country.

<table>
<thead>
<tr>
<th>Population (in thousand inhabs.)</th>
<th>Radial &amp; Tangential using 1 line</th>
<th>Tangential using 2 lines</th>
<th>Ratio [1]/[2]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>No./[1]</td>
<td>No./Inhab.</td>
<td>No./[2]</td>
</tr>
<tr>
<td>Haute-Picardie</td>
<td>0.4</td>
<td>11</td>
<td>275.00</td>
</tr>
<tr>
<td>Montbard</td>
<td>6.0</td>
<td>5</td>
<td>8.33</td>
</tr>
<tr>
<td>Vendôme</td>
<td>18.0</td>
<td>18</td>
<td>10.00</td>
</tr>
<tr>
<td>Calatayud</td>
<td>22.0</td>
<td>14</td>
<td>6.36</td>
</tr>
<tr>
<td>Puertollano</td>
<td>52.0</td>
<td>46</td>
<td>8.85</td>
</tr>
<tr>
<td>Segovia</td>
<td>55.0</td>
<td>31</td>
<td>5.64</td>
</tr>
<tr>
<td>Cuenca</td>
<td>57.0</td>
<td>18</td>
<td>3.16</td>
</tr>
<tr>
<td>Ciudad Real</td>
<td>75.0</td>
<td>46</td>
<td>6.13</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>85.0</td>
<td>14</td>
<td>1.65</td>
</tr>
<tr>
<td>Toledo</td>
<td>85.0</td>
<td>15</td>
<td>1.76</td>
</tr>
<tr>
<td>Arras</td>
<td>86.0</td>
<td>20</td>
<td>2.33</td>
</tr>
<tr>
<td>Le Mans</td>
<td>145.0</td>
<td>31</td>
<td>2.14</td>
</tr>
<tr>
<td>Tours</td>
<td>150.0</td>
<td>28</td>
<td>1.87</td>
</tr>
<tr>
<td>Albacete</td>
<td>172.0</td>
<td>21</td>
<td>1.22</td>
</tr>
<tr>
<td>Reims</td>
<td>200.0</td>
<td>32</td>
<td>1.60</td>
</tr>
<tr>
<td>Valladolid</td>
<td>315.0</td>
<td>38</td>
<td>1.21</td>
</tr>
</tbody>
</table>

Table 2 - Number of services by population. Source: authors.

3. CITIES AND STATIONS

Cities/stations are grouped according to their distance to the metropolis and size (Table 3).

a) Those at the metropolitan urban continuum, up to 30 km., where their size is not relevant since besides there are other urban areas normally well connected to the station.
b) Those within **areas of clear metropolitan influence** but discontinuous urban areas, between 30-90 kilometres or up to half an hour HSR travel time, where city size becomes relevant since urban and transport systems are not continuous.

c) Those further away in **areas with relevant but decreasing metropolitan relations**, between 100-250 kilometres or up to one hour HSR travel time, where city size is very relevant since the city system can be very discontinuous.

HSR services in all but one case (Montbard) allow half a day return from/to Madrid or Paris. Reversely, possibilities along tangential services vary considerably.

### 3.1. CITIES/STATIONS WITHIN THE METROPOLITAN URBAN CONTINUUM

This happens with three stations near Paris, along the HSR by-pass (Figure 2) and the metropolitan rail (RER) and bus system (Table 3), at key metropolitan poles: MLV new town east end which includes a scientific pole, CDG airport city a secondary economic pole (Halbert, 2004) and Massy recent ‘technopole’. All three areas are experiencing transformations related to their location, policies and improved accessibility.

a) **Interchanger/Destination HSR stations.** **MarneLV-Chessy** and **Roissy-CDG** are at relevant transportation destinies (Eurodisney and Charles-de-Gaulle airport), reinforcing their interchanger character¹. Both interconnection stations are integrated in each transportation pole (Park entrance and terminals) and benefit from their other transportation services, which are very important for them².

With the MLV-Chessy station, more foreigners coming by HSR were expected (serves London and Brussels). In 2012, the daily services included 70 trains and 60 cities (Disneyland Paris website), and services increased since 2013, with the launch of Ouigo, low cost HSR (Delaplace and Dobruszkes, 2015). Development around the station is directly linked to DisneyLand Paris (Mohino et al., 2014), with a tourism development cluster with the participation of several public³ and private actors. In 20 years, there were 250 millions of visitors in DisneyLand Parks, and according to SNCF, in 2008, 57 % of the HSR clients are there for the Parks.

The Roissy-CDG station, with almost 4 million passengers in 2011, was the second new HSR station behind Lille Europe and serves 60 destinations (Dobruszkes et al., 2014). The combined

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¹ Bus Transport, Highway A4, Airport CDG (231 world destinations) (Data January 2013, OAG, Dobruszkes et al., 2014).
² Disneyland pay 1/3 of the cost of building this station, even if the traffic was limited in the years 2000 (4,000 travellers per day).
³ The University of Paris-East, the SAN Val d’Europe, the French State -Départé Interministèriel for Euro Disneyland Project and EPA France-, the general Council of Seine-et-Marne and the Regional Council Île-de-France.
metropolitan, national and international transport interchanger and the Paris nearness is encouraging some new business urban developments (Mohino et al., 2014).

b) **Without major metropolitan elements.** Massy HSR station is besides the long distance, metropolitan and bus stations, within walking distance from Massy city centre (0.8km), traditionally a railway junction/station and an industrial and residential area, not far from Orly airport (8.5 km). The HSR network allows services calling also at the central Montparnasse station, nevertheless no ones are offered.

Initially there was no urban project around the station. With the Interconnection South project, which nevertheless has been postponed (Duron Report, 2013), there were some new ones. There was a later change (Mohino et al., 2014) to transform this suburban area into a technopole (Bontje and Burdack, 2005), following the state’s decision to relocate research/university facilities to take advantage of favourable characteristics (vacant land, transport linkages, amenity-rich area).

### 3.2. CITIES/STATIONS WITHIN THE METROPOLITAN URBAN DISCONTINUOUS AREA

Some small and intermediate HSR cities up to 30 minutes HSR travel time to/from the metropolis have increased their population, attracted economic activities and housing investments, and now display the potential of becoming metropolitan sub-centres (Ureña et al., 2009a; Garmendia et al., 2012b).

This three cities/stations are Spanish small historic-administrative cities (provincial capitals), located along three HSR lines (Figure 1.a. and Table 3). Guadalajara is connected to the metropolitan rail, Segovia has a weak connection (very few services) and Toledo is not connected. In Guadalajara and Segovia the HSR and the conventional rail stations are distant and with bad connections. Segovia and Toledo are relevant tourist destinations and university cities (Garmendia et al., 2012 and Mohino et al., 2014).

a) **Through peripheral HSR stations** (Figure 1.a. and Table 3). Guadalajara is on a continuous and very populated, industrial, logistics and transportation corridor from Madrid\(^1\), thus the HSR maintains its territorial setting. Segovia was a dead-end of a second homes corridor, while the HSR and the recent motorway to Valladolid have produced a through location, which will have a strong long term territorial effect. Both stations are peripheral, but while Guadalajara location is really isolated, the Segovia one is on a local corridor towards the royal historic town and palace of La Granja.

\(^1\) 35 km distance from the Madrid airport.
### Table 3 - Typology of HSR Cities/Station up to one hour from Madrid and Paris.

<table>
<thead>
<tr>
<th>HSR station</th>
<th>Dist. to Metro Centre (min by HSR)</th>
<th>Population (thousand)</th>
<th>Tourist attraction</th>
<th>Station Type and distance to city centre</th>
<th>Urban development around station</th>
<th>Relevance of tangential services using two HSR lines</th>
</tr>
</thead>
<tbody>
<tr>
<td>MarneLV-Chessy</td>
<td>35 km*</td>
<td>Parisian UA**</td>
<td>Yes</td>
<td>Central to Eurodisney</td>
<td>Yes (Eurodisney)</td>
<td></td>
</tr>
<tr>
<td>Massy</td>
<td>16 km*</td>
<td>Parisian UA</td>
<td>No</td>
<td>Central</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>Roissy-CDG</td>
<td>25 km*</td>
<td>Parisian UA Business Tourism</td>
<td>Central to airport</td>
<td>Yes (Airport City)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Guadalajara</td>
<td>23 min</td>
<td>85</td>
<td>No</td>
<td>Peripheral, 8,5 km Planned &amp; small part built</td>
<td>0% &amp; Small in future</td>
<td></td>
</tr>
<tr>
<td>Toledo</td>
<td>33 min</td>
<td>85</td>
<td>Yes</td>
<td>Besides Centre Planned not built</td>
<td>0% &amp; Very Small in future</td>
<td></td>
</tr>
<tr>
<td>Segovia</td>
<td>26 min</td>
<td>55</td>
<td>Yes</td>
<td>Peripheral, 6 km Planned not built</td>
<td>0% &amp; Relevant in future</td>
<td></td>
</tr>
<tr>
<td>Calasuyd</td>
<td>55 min</td>
<td>22</td>
<td>Moderate</td>
<td>Beside Centre</td>
<td>No</td>
<td>0% &amp; Moderate in future</td>
</tr>
<tr>
<td>Haute-Picardie</td>
<td>42 min</td>
<td>0.4</td>
<td>No</td>
<td>Peripheral</td>
<td>Small</td>
<td>20%</td>
</tr>
<tr>
<td>Montbard</td>
<td>64 min</td>
<td>6</td>
<td>Small</td>
<td>Edge</td>
<td>No</td>
<td>0% &amp; Small in future</td>
</tr>
<tr>
<td>Vendôme</td>
<td>44 min</td>
<td>18</td>
<td>Moderate</td>
<td>Peripheral, 5 km Planned not built</td>
<td>0% &amp; Small in future</td>
<td></td>
</tr>
<tr>
<td>Arras</td>
<td>49 min</td>
<td>86</td>
<td>Moderate</td>
<td>Central</td>
<td>Yes-Moderate</td>
<td>10%</td>
</tr>
<tr>
<td>Ciudad Real</td>
<td>53 min</td>
<td>75</td>
<td>No</td>
<td>Edge</td>
<td>Related moderately to HSR</td>
<td>5% &amp; moderate in future Allow day return to one Spanish city (only 5 hours in destination)</td>
</tr>
<tr>
<td>Cuenca</td>
<td>51 min</td>
<td>57</td>
<td>Yes</td>
<td>Peripheral, 6 km</td>
<td>No</td>
<td>23% &amp; moderate in future Allow day return to two Spanish cities (only 5 hours in destination)</td>
</tr>
<tr>
<td>Puertollano</td>
<td>73 min</td>
<td>52</td>
<td>No (hunting)</td>
<td>Central</td>
<td>Not related to HSR</td>
<td>5% &amp; moderate in future Allow day return to one Spanish city (only 5 hours in destination)</td>
</tr>
<tr>
<td>Albacete</td>
<td>80 min</td>
<td>172</td>
<td>No</td>
<td>Besides Centre</td>
<td>No</td>
<td>0% &amp; Moderate in future</td>
</tr>
<tr>
<td>Le Mans</td>
<td>55 min</td>
<td>145</td>
<td>Intermediate</td>
<td>Central</td>
<td>Yes-Important</td>
<td>13%</td>
</tr>
<tr>
<td>Reims</td>
<td>45 min</td>
<td>200</td>
<td>Yes</td>
<td>Central &amp; Edge</td>
<td>Yes in centre Moderate in edge</td>
<td>25% - Allow day return to several French cities</td>
</tr>
<tr>
<td>Tours</td>
<td>59 min</td>
<td>150</td>
<td>Yes</td>
<td>Central &amp; Edge</td>
<td>No in centre Moderate in edge</td>
<td>11% - Allow day return to several French cities</td>
</tr>
<tr>
<td>Valladolid</td>
<td>61 min</td>
<td>315</td>
<td>Intermediate</td>
<td>Central</td>
<td>Planned not built</td>
<td>0% &amp; Moderate in future</td>
</tr>
</tbody>
</table>
Urban developments or plans are underway besides both stations. In Guadalajara, ‘Valdeluz city’ is to include 9,500 dwellings and industrial activities, by 2012 the street network, a golf course and 10% of the dwellings were built, only one third of them have tenants (Garmendia et al., 2012), and construction has stopped. The Segovia HSR station with possibilities of being articulated into the Segovia-La Granja urban axis, has generated abundant plans for an economic activity area; nevertheless, no development has yet taken place (Mohino et al., 2014).

These stations have different topological network settings. Guadalajara has no tangential using two HSR lines and very few radial HSR services, 9 in each sense, serves only 14 destinations, and very low number of passengers (around 80,000 in 2010). It is occasionally used by Madrid north-east inhabitants that find it easier to reach it instead of the Madrid central ones (Garmendia et al., 2014). Segovia\(^1\) with almost 1 million passengers in 2009 (Garmendia et al., 2012), is served by 19 trains in each sense to/from 33 destinations, mostly with very low frequencies, except for 19 frequencies with Madrid and Valladolid.

b) Terminus HSR central station. Toledo (Figure 1.a.) has become the capital of Castilla La Mancha region and is surrounded by an area with 60% more population. The terminus HSR station (conventional infrastructure and services cancelled) is within walking distance of the historic city, serves only Madrid (and occasionally from Madrid to other destinations). With 1.5 million passengers and 34 services, it is intensively used for commuting (around one third) and tourism (around two thirds) (Garmendia et al., 2012). There are no tangential services (one existed during one year but was cancelled due to small number of passengers).

There is vacant land besides the station with plans to develop offices; nevertheless with the river flooding area and the building crisis no development has taken place (Mohino et al., 2014).

3.3. CITIES/STATIONS WITHIN AREAS OF RELEVANT METROPOLITAN INFLUENCE

3.3.1. Very small cities

These HSR stations exist in a few cases when a HSR line passes nearby (no line was deviated to reach very small places\(^2\)) or as compensation for devaluing pre-existing rail corridors.

a) Central-edge conventional and HSR stations (Figure 1 and Table 3) at their original station location, within walking distance from very small town’s centres. Calatayud and Montbard are the poles of rural scarcely populated sub-regions and have some tourist attraction (Mudéjar art at Calatayud and UNESCO World Heritage Abbey of Fontenay near Montbard). No developments are

\(^1\) This line is being developed to the north (Galicia, Asturias, Basque Region), which will improve the connectivity of this city.

\(^2\) A few lines in Spain have been deviated to reach major cities such as Tarragona or Albacete.
taking place near the station, although they are seen as major sub-regional infrastructures (the Logistics Military Academy was relocated to Calatayud just before the HSR arrived (Ureña et al., 2012)).

Calatayud was already served by long-distance and regional conventional services previously and now maintains these good long distance connections, 14 destinations, via HSR (see Table 3), nevertheless the number of radial services is low (9 each sense to/from Madrid), with half of them also being tangential using one HSR line (5 services each sense to/from Guadalajara), while there are no tangential using two lines services.

Montbard is besides (20 km) the HSR/conventional junction conventional and has very few HSR direct services and destinations -eight-, and no tangential using two HSR lines. Nevertheless, it has conventional regional rail services to many destinations.

b) Peripheral HSR stations. Vendôme (Figures 1.b.), a small historic town, the biggest one in an intermediary populated rural area (70,000 inhabitants), with several large industrial plants. Initially HSR services were limited but they have slightly grown and currently around 400 persons travel daily to/from Paris. No tangential using two lines services (Table 1), very few destinations (Paris, Tours and Bordeaux) and day return travel only to/for Paris and Tours. HSR has re-established its location on a transportation corridor (the Paris-Spain corridor went through it while the motorway doesn’t). The station was a political choice after negotiations, since in this rural environment no municipality wanted to house the HSR.

In 1983 a technological park was launched on 140 ha near the HSR station, together with a touristic and urban residential development, in cooperation between public actors¹, but conflicts occurred and realisations are limited (Mannone, 1995). In 2010 there are only 22 enterprises on 6.6% of the park area (Fachinetti-Mannone, 2013) and an insurance company relocated its regional office and established a nationwide training centre (Ureña et al., 2012).

c) HSR Stations in the countryside. Haute-Picardie HSR station (Figure 1.b.) is at a very scarcely populated rural area without towns nearby, at a road/motorway junction, half the way between Paris and Lille and Amiens and Saint Quentin, the cities along the conventional railway to Calais-London and Brussels, and is a compensation for suppressing tem. HSR services only use the by-pass stations². It has no other rail connexion, only a bus from Amiens. A big parking (580 spaces) is used by around 150 cars and there are 420,000 passengers/year³.

¹ TGV association, city, department, regional council but also private actors and SNCF.
² One return was experienced with Paris Nord central station but it didn’t work.
³ FNAUT users’ association. See also http://fresques.ina.fr/picardie/impression/fiche-media/Picard80519/la-gare-tgv-haute-picardie-a-acceulli-3-millions-de-passagers.html.
Nevertheless its isolation, a small agro-industrial/logistic development has taken place besides the station on 40 ha with a few enterprises\(^1\), often relocated existing ones, as in most ‘activity areas’ at peripheral stations (Fachinetti-Mannone, 2013). Several extension projects were launched\(^2\), but in 2013, enterprises are lacking (only 6 are here) and 78 ha serviced lots are empty (2/3 of the 110 ha) due to the economic crisis and the competition by other activity parks.

### 3.3.2. Small cities

These HSR stations exist only at the few places HSR lines pass nearby, since lines only deviate slightly to reach them. All except one (Puertollano) are administrative capitals and have recent universities, all except one (Cuenca) are surrounded by as much population as they have, and all improve their articulation to national transportation corridors: Arras becoming the Paris door for north-west France, Ciudad Real and Puertollano were 50 km away from corridors, and Cuenca changed from a dead-end to a through situation.

**a) Central-Edge conventional and HSR stations.** **Arras**, a small historic/touristic city, 45 km south of Lille (agglomeration of one million inhabitants), included in a populated territory. **Ciudad-Real and Puertollano**, twin cities 40 km apart in a medium populated territory but isolated from big cities and with no tourist attraction, although hunting is important nearby (Figure 1.b.).

The Arras station was not in the initial project but was obtained through negotiations\(^3\) (Berger, 2005), located just outside the Paris-Lille HSR line Paris-Lille (13 km), were abundant HSRs deviate to serve the Nord-Pas-de-Calais region, transforming Arras into very well served in relation to its size (Menerault and Barré, 2005). Reversely, it only has four tangential services (2 with Haute-Piccardie, 1 with Le Mans and 1 with Tours). Its traffic has grown\(^4\) around 40% from 1997 to 2010.

Totally renewing the station district, the ‘Centre Européen d’Échanges et de Communication’, **ATRIA**, created besides the station over 3.6 ha dedicated to offices, conference and commercial spaces, a hotel and a parking (1,200 spaces) as alternative to Paris and Lille locations. Nowadays, **ATRIA** is a small regional development (with a percentage of public offices), with room for more development. Arras hopes that economic development can occur due to saturation at Lille, and redesigns its strategy based on HSR (SCOT, 2011) by developing residential buildings and a new European station.

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1. As the head office of La Vermandoise de Sucreries, Maia Sonnier, Degomme Bocard, SPL Irisbus and some production enterprises (Panavi and Potato Masters).
2. In 2008, a 70 ha industrial area financed by the ‘Communauté de communes de Haute-Picardie’ (26 rural towns, 8000 inhabitants) (65%) and by the general Council of the department Somme, the Feder, the French State and the Region (35%). A logistic park named ‘Acitologis’ of 11 ha with HQE label should be built by Nexity Geprim in 2010. An agro-industry village ‘Village Agro’ should also be built.
3. In 1992, the mayor of Arras and the president of department obtain the HSR stop in Arras in order to contribute to its dynamism.
4. This is the number of go up and down in this station according to SNCF Data. From 1993 to 1997 data are not available.
At Ciudad Real the station was relocated to the edge of its dense built-up area, within walking distance from its centre (1.3 km). Developments around the HSR station are related only moderately to HSR, although its general development cannot be understood without referring to it (Garmendia et al., 2008). At Puertollano the HSR station is by the city centre, with housing developments around it, which would have happened similarly without the HSR. Both Ciudad Real and Puertollano have very good HSR services (Tables 1, 2 and 3) connecting them to 20 destinations.

b) Peripheral HSR stations. Cuenca (Figure 1.a. and Table 3) a major tourism attraction (World Heritage UNESCO), was at a dead end situation as Segovia, and the HSR has relocated it half the way between Madrid and Valencia (fourth most populated urban area).

The number of radial and tangential services is small, but ratios are high related to its small size. It is connected to 27 destinations, because it is before the Madrid-East HSR line subdivision towards Valencia and Alicante-Murcia. On the other hand, the number of passengers is quite small (around 70,000 in 2012).

No urban development is taking place/planned around the peripheral HSR station.

3.3.3. Medium size cities

HSR serves these cities because the conventional rail and road corridors passed through them and the HSR normally maintains them. Due to their size they have abundant HSR and conventional services as well as the best tangential HSR using two lines services, some of them allowing for day return travel (i.e. Reims or Le Mans). All have universities, and most have tourist attraction (except for Albacete) and are administrative capitals.

a) Central conventional and HSR stations. Albacete, Le Mans and Valladolid (Figures 1.a. and 1.b.), all except Albacete experience/plan important redevelopments besides their stations.

Albacete HSR station maintains its previous location (edge of the city), within walking distance from the city centre (0.7 km) and besides the bus station. Its surroundings are not subject of any major redevelopment project (during the 1970’s the station was moved 400 meters east allowing for developments and a north south boulevard). The HSR is very recent (started operation in 2010) and has a reduced number of services, more evident in the radial (12) and tangential using two lines (cero), than in the tangential using one line (8) ones. Previously, the conventional rail line connecting Madrid with the eastern coastal cities (Alicante, Murcia, Valencia) passed through Albacete and the HSR has suppressed those with Valencia reducing its railway junction relevance. Nevertheless, Albacete is still connected to more than 20 destinations.
Le Mans obtains that HSR uses the city centre and a second station is opened in the south. The HSR is characterized by radial services, in competition with regional conventional services (TER), and tangential ones using two lines. The HSR produced a big mobilization against the growth of ticket price.

During the mid-1980’s, Le Mans was not the most favourable city to enhance value from the HSR, but since the 1990’s crisis, HSR has been used to renew the city and for a large local consensus, which didn’t exist, either public or private, around Novaxis redevelopment project near the central HSR/conventional station (Bazin et al., 2006). The aim was to attract firms from the city, the region, the country or outside, and was built in 1988, before the HSR arrival. ADEMA (public agency of economic development) and the location of ‘Mutuelles de Le Mans’ have been very important in promoting this business district. The strategy also included two technological parks «Université» and ‘Circuit du Mans’.

But despite the comparative low office prices (4 times higher in Paris) and the grants for establishment, the commercialisation of Novaxis was difficult, due to the 1993 economic recession and because firms, especially head offices, prefer Paris for its relevant image effect; nevertheless, by the turn of the XXI century, around 50,000 m² of new offices had been built and had 2,000 jobs, half being new jobs; 1/3 of the activities located at Novaxis come from Le Mans, 1/3 from Paris Region and 1/3 are new firms (Bazin et al., 2006). Today, in Novaxis there are 140,000 m² of offices, 132 enterprises and 3,250 jobs.

In 2006, a new project Novaxud was launched, an eco-district located behind Novaxis, which should be finished by 2020. It includes offices, but also housing and a large underground parking.

Valladolid (Figures 1.a.), has become the capital of the Castilla y Leon region and is an important industrial pole (i.e. Renault car assembly). A crucial urban project has been approved to redevelop 66 ha of central rail land and to put underground 6 km of rail tracks that divide the city (Bellet et al., 2012). Nevertheless, the present crisis has postponed the project.

b) **Twin HSR stations**, the central one with conventional and HSR services and the peripheral one with HSR services, are normally connected by rail, with central stations receiving most city-
Paris services, and peripheral ones most greater distance and tangential using two lines ones. **Reims** and **Tours** are of this type and experienced urban redevelopment by central stations and plans/projects by peripheral ones.

Reims is the biggest city at a territory 2.5 times more inhabited, although not its capital. Major redevelopment has taken place around the central station (at its north-west side, establishing a new north side entrance to the station and redeveloping parts of the XIX century industrial area of Claimarais); the renewal took place before the HSR arrival, when 70 000 m² of offices were built or renewed. The offices have been sold quickly. A hotel, housing and a parking (more than 600 places) have also been built. Moreover urban transport lines were modified, including a tramway with the city centre and the peripheral station. On top, there were new real estate actors at the city

The peripheral station is just outside its south-west edge, besides social housing. An industrial and office area (180 ha) was planned and developed between the city edge and the new station: with economic activities (65 ha), residential real estate (20 ha), leisure activities and collective services (25 ha), green zones (40 ha) and a 600 places parking (the later already built). Much of this area is still unused due to the economic situation1 and to the image of this part of the city, but things are currently changing.

There was also consultation between local actors especially between department and region, but Reims plays in a solitary manner. There were also communication campaigns on ‘45 min by TGV from Paris’ by ‘Invest in Reims’ development agency to renew the city image.

Tours (Figure 1.b.) is an important railway junction (Troin, 1995) and the centre of the Loire valley, with its Castles (World UNECSO heritage). The second station (Saint Pierre des Corps) is in a different municipality, at a large railway area within the city continuous urban area but to the other side (east) of the motorway besides a housing and industrial part of the city. Due to their proximity, it is difficult to analyse them separately but expectations/policies were different and cooperation between the two municipalities is inexistent.

In Tours central station services are quite limited (4 HSR in each sense to/from Paris) and the city had no expectations and projects (i.e. the Congress centre was expected with or without HSR and built in 1993, after its arrival). This lack of projects was also because the main station has always been Saint Pierre des Corps and because Tours was already an attractive city with high real estate prices.

Saint-Pierre-des-Corps benefits from good HSR services. The jobs are linked to the rail activity (1/3 of the total jobs) and HSR is seen as a tool to attract jobs and promote urban renewal. Several projects have been developed: a new station, a parking (460 places), offices (10 000 m²) and a hotel

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1Even if 80% of the land is sold.
(100 rooms). The ‘ZAC gare (station area agreed development)’ aim was to restructure the district and to combine economic activities, shops and housing. An industrial park was also renewed. Moreover the political actors which remain the same have conducted this long term Project but financial constraints have limited the project.

4. CONCLUSIONS

Transport networks topologies shape/condition the relations between different territories, and increasingly so their long run ones, and the characteristics of territories and local policies conduce to specific valorisation of transport networks and services.

Two HSR networks topologies have been considered, with different ways to interconnect radial lines near the metropolitan centre and with different distances to the nearest HSR stations, with more tangential services in France than in Spain. One limitation for our analysis derives from the network in Madrid not being complete, since the HSR tunnel connecting the two central stations is still not operational.

The HSR network in the vicinity of Madrid has a positive aspect and three negative ones. Tangential services don’t increase their travel time or length substantially. The three negative aspects are that Madrid and its immediate urban continuum have only one type of HSR station, thus reducing the travel alternatives, that several tangential services are (and will be) pure tangential ones thus reducing their economic viability and that two radial lines will not be interconnected, thus excluding them from possible tangential services.

The HSR network in the vicinity of Paris adds two positive aspects and a negative one. Paris and its immediate urban continuum have two types of stations, thus increasing the travelling alternatives, and that all tangential services are also used by radial passengers (to/from Paris) and thus improving their economic viability. The negative aspect is that the by-pass increases the travel time of many tangential services.

HSR services to/from the two metropolises always exist quite abundantly and only one city cannot have half a day return trips, tangential using one line services are also frequent, while the differences come from tangential using two lines services. The latter are never abundant (maximum of five in each sense) and often don’t exist in small cities, they happen in the same proportion, in France only two out of seven cities don’t have them and in Spain in three out of nine. In France they are slightly more frequent, thus, combined radial-tangential HSR networks help to improve possibilities of tangential cohesion.
Service frequency has some weak relation to population, but the additional conclusions, made clear in this paper, are that service frequencies are also importantly related to the network topology, thus obtaining a HSR network topological privileged position might be crucial for having abundant services, and that HSR has suppressed some traditional city isolations and recovered some traditional location at relevant national corridors, thus in both cases improving relevantly their territorial possibilities.

Urban developments adjacent to HSR stations are different depending on their physical, economic and locational circumstances and on conducted policies. Previous studies show that central HSR station surroundings have experienced more relevant urban transformations than peripheral ones. Nevertheless this study shows different conclusions depending on the size and distance to the metropolitan core:

a) Up to a small distance from the metropolitan centre (35 km in Paris) almost all types of stations produce and/or are affected by urban developments, policies and/or projects. It is as if up to this distance all areas are under an urban dynamism that HSR may speed up and that may take place anywhere, not only by urban centres. This takes place also in other metropolitan regions such as London (Mohino et al., 2014). Up to this distance some HSR stations integrated into major attraction or transportation poles provide an additional asset.

b) At intermediate distances from the metropolitan centre (40 to 90 km in Madrid) the HSR stations are by small cities and urban transformations are more plans than actual realities both at central and peripheral stations. It is as if in the short run the existing cities could cope with the envisaged new activities and also as if all places of these small cities were considered to be close to their HSR station and thus no need for redevelopment near the station. Ashford near London follows this process (Mohino et al., 2014), while the exception is Guadalajara.

c) At further distances from the metropolitan centre (100-240 km in Madrid and Paris) the diversity is greater, but in general developments take place profusely around central stations at bigger cities and in a much more limited manner at smaller cities or towns and also around most peripheral stations. This third situation is more in accordance with what was concluded by previous studies.

In relation to the influence of size in the existence of urban transformations, its looks as if they almost don’t take place at very small places (Calatayud, Haute-Piccardie, Montbard and Vendôme) for any type of station location and to a lesser extent at small size cities (Cuenca, Puertollano and Segovia).

Most cities/stations have abundant radial HSR services, but stations also with a certain percentage of tangential HSR services show greater development possibilities. This does not happen in very small places, in which the percentage of non-radial is a consequence of their very small number of radial services more than from an important number of non-radial ones (Haute-Piccardie). On the contrary there is a positive relation between percentage of non-radial services and urban development around
the HSR stations for small and medium size cities (Reims, Le Mans, Arras), but this is not the case for small size cities only with peripheral stations (Cuenca).

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Figure A.V.1 - Cumulative opportunity indicator: a notorious extension of FUA centres’ catchment areas.

Figure A.1. (Continued). Cumulative opportunity indicator: a notorious extension of FUA centres’ catchment areas. **A.1.e.** Tomelloso. **A.1.f.** Ciudad Real. **A.1.g.** Albacete. *Source: authors.*

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EXTENDED ABSTRACT (ENGLISH VERSION)

Mobility Patterns in Peripheral Areas of Multicentric Metropolitan Regions: Radial versus Tangential Functional Linkages.

The Case of Castilla-La Mancha in Relation to the Madrid Metropolitan Region

1. INTRODUCTION: THE NEW URBAN AND MOBILITY PATTERNS

During the last decades, traditional monocentric metropolitan areas have evolved towards more polycentric/multinodal urban structures, and consequently more complex mobility patterns (centre-periphery, periphery-centre, periphery-periphery) have emerged (Clark and Kuijpers-Linde, 1994; Van der Laan, 1998). There are undeniable relations between mobility and urban form, which have mainly been studied through labour commuting flows since they constitute the greatest daily recurrent travel.

This paper complements existing studies by analysing if complex functional relationships taking place within traditional metropolitan areas also characterize more distant areas of Multicentric Metropolitan Regions (approximately between 50 and 250 km from the metropolitan centre).

The analysis is focused on the Madrid Metropolitan Region, which has undergone noteworthy changes in its urban structure and transport system during the last three decades. As a consequence, metropolitan processes started to overflow beyond Madrid province administrative boundaries, giving raise to strong functional linkages with adjacent provinces. In parallel, during the 1980s a state re-scaling took place in Spain. Therefore, in order to analyse the influence of these processes on mobility patterns, the study area covers two different Autonomous Communities (NUTs-2 in the European Nomenclature), that is, Castilla-La Mancha (CLM) and Madrid, and the study period spans from 1981 to 2012, before and after the consolidation of these politico-administrative regions. CLM has traditionally been defined as a disorganised, without functional cohesion and acephalic/leaderless region conspicuously influenced by Madrid.
Three main sources of information have been used to carry out the analyses: the 1981 Spanish National Census, the 2001 Spanish National Census and an own-elaborated 2012 mobility survey (since the information of the 2011 Spanish National Census is still not available).

The present analysis of territorial articulation is carried out under a double approach:

- On the one hand, by looking at the commuting patterns evolution (1981-2001-2012). Firstly, in absolute terms (as the number of trips originated at each municipality) to identify cities leading regional mobility patterns (in terms of strength of interaction). Secondly, in relative terms (as the percentage of outward commuting directed to a certain destination) to understand the centrality re-configuration of destinations.

- On the other hand, by characterizing 2012 regional business travel patterns and comparing them with the 2012 regional commuting ones. Besides, by analysing the evolution of business relationships (between 2006 and 2012) for one of the Castilla-La Mancha provinces (Ciudad Real).

In order to characterize the polarization capabilities of the CLM main centralities of the Multicentric Metropolitan Region, different types of relationships are identified according to the centres they are directed to: intraprovincial (hierarchical towards the capital city and non hierarchical towards other provincial destinations), radial (hierarchical towards the metropolitan centre and non-hierarchical towards the rest of the Madrilenian municipalities), tangential (hierarchical towards the regional capital city, Toledo, and non-hierarchical towards the rest of the CLM municipalities, excluding those of the same province of residence) and interregional (towards other Spanish regions excluding Madrid).

2. EMPIRICAL RESULTS

2.1. A NOTEWORTHY INCREASE AND A GREATER MULTIDIRECTIONALITY OF COMMUTING PATTERNS.

Out-commuting flows have greatly increased both in intensity and in number of municipalities reached between 1981 and 2012, multiplying by 2-10 times in 2001 and by 3-20 times in 2012 those existing in 1981. This noteworthy increase could be explained by the duplication of car ownership and female working ratios, by the travel time reductions within the study area thanks to transport improvements and by the progressive integration of CLM into metropolitan processes.

- In that sense, between 1981 and 2012, intraprovincial (generally greater towards the provincial capital cities) and radial (in general, greater towards Madrid) flows have considerably increased. The reinforcement of the last ones has been more significant between 1981 and 2001,
since during that period of time some Madrilenian municipalities start acquiring a metropolitan sub-centre role.

- In regards to the tangential flows towards Toledo, whilst they didn’t exist in 1981, they appear in 2001 favored by the state re-scaling and the conformation of the regional capital in Toledo in 1982, except for those municipalities for which Madrid was in between (Guadalajara province). In 2012, travel time reductions, thanks to the new CM-42 motorway, has had a notorious impact on these tangential flows, increasing from the central CLM area (Alcázar de San Juan, Tarancón and Villarrobledo). Conversely, the rest of tangential flows already existed in a few municipalities in 1981, although they were weak. In 2001, all surveyed municipalities showed this type of flow, having increased for most of them (fifteen out of twenty municipalities) in 2012. This multinodal mobility pattern supports the hypothesis of emerging new centralities within the CLM region.

- Similarly, interregional flows were weak in 1981, being more significant in the most distant municipalities from Madrid (and especially for eastern municipalities, traditionally more related to Mediterranean Metropolitan Areas). Between 1981 and 2001 there was a general increase of this type of flows, while they reorganize between 2001 and 2012, increasing in the two capital cities more distant from Madrid (Albacete and Cuenca) and decreasing in the three other provinces.

Looking at the organization of these out-commuting flows, two tendencies can be observed. The first one between 1981 and 2001, when Madrid reinforced its traditional attraction as the main destination of extraprovincial flows, both for near and distant municipalities. The second one during the last decade, characterised by a weakening, in percentage terms, of Madrid’s polarisation role together with a strengthening of tangential relations (although still weak and only in a reduced number of municipalities close to the central area of CLM), giving rise to more complex mobility patterns.

2.2. BUSINESS FLOWS SPATIAL PATTERNS.

The comparison between the 2012 regional commuting and business travel patterns reveals that: firstly, the second ones take place along longer distances; secondly, they are less complex since flows are centralised in a smaller number of high centrality destinations (mainly Madrid and to a lesser degree, the provincial capitals); and thirdly, total tangential business linkages are clearly greater than tangential commuting ones.

On the other hand, the diachronic analysis of business travel (between 2006 and 2012) shows the consolidation of a more complex mobility pattern due to destination diversification.
4. CONCLUSIONS

The present article complements recent literature on Multicentric Metropolitan Regions by analysing their more distant territories and by exploring if complex mobility patterns occurring up to a certain distance from metropolises (approximately, 40-50 km) also take place further away (up to 250 km).

Empirical results show that distant areas of the Madrid metropolitan region have considerably increased their work-related intermunicipal flows during the last three decades, after the Spanish State re-scaling process. Moreover, the structure of functional relationships have increased their complexity, with new functional linkages in addition to the traditional ones towards the provincial capital cities: tangential between similar territories within these distant areas, radial between these distant areas and the traditional metropolis and interregional between distant areas and other regions. Despite the emergence of these complex interaction patterns within distant territories of metropolitan regions, they are still much less developed than those of nearer areas and they are still dominated by intraprovincial and radial flows.

Nevertheless, several new spatial patterns are appearing and can be recognised in these distant parts of the metropolitan regions:

1. Municipalities closer to the metropolis maintain or increase their radial flows, being the only ones that interact with other metropolitan sub-centres of the Madrid province.

2. The attraction capacity of the metropolis means that up a certain distance (in Madrid around 150 km) radial interactions are stronger than hierarchical ones to the provincial capitals.

3. The high relevance of intraprovincial flows in distant areas evidence the low development of polycentric structures at the intra-regional level, where each provincial capital still exerts an important influence, while only a limited, although growing, number of trips take place beyond each province’s administrative boundaries.

4. Attraction capacities of new regional capitals do not reach that of metropolitan cores, and only for business-related flows total tangential relations equal or even exceed total radial ones.

Municipalities with greater centrality capacities (size, public administration, public services, economic activities, etc.) tend to develop intermediary roles attracting a greater percentage of flows from lower centrality level municipalities and conversely their own outward relations increasingly take place with the metropolises or other municipalities of their same centrality level.
FULL PAPER (SPANISH VERSION)

Patrones de movilidad en áreas distantes de regiones metropolitanas multicéntricas: radialidad vs. tangencialidad. El caso de Castilla-La Mancha respecto a la Región Metropolitana Madrileña

Resumen
El artículo aborda la evolución de los patrones de movilidad laboral (commuting y negocios) de áreas distantes de Regiones Metropolitanas Multicéntricas. Tomando Madrid y Castilla La Mancha como caso de estudio, se pretende analizar la evolución (1981-2012) de las relaciones funcionales de la región castellano-manchega con la metrópoli y las tangenciales dentro de ella, con especial atención a las dirigidas a la capital regional. Los resultados muestran que frente a la predominancia de los flujos intraprovinciales y radiales, los tangenciales comienzan a adquirir importancia en los patrones de movilidad.

Palabras clave
Patrones de movilidad, Commuting, Relaciones de negocio, Regiones Metropolitanas Multicéntricas, Capital Regional.
1. INTRODUCCIÓN

Las redes de transporte han influido fuertemente en el desarrollo económico, las estructuras urbanas y los patrones de movilidad y viceversa (Biehl, 1991; Gutiérrez-Puebla y García-Palomares, 2007) y las mejoras de las últimas décadas, junto a un aumento de la movilidad, han jugado un papel clave en el devenir metropolitano, dando lugar a estructuras urbanas de mayor complejidad, donde los tradicionales modelos monocéntricos han comenzado a evolucionar hacia otros de tipo policéntrico, así como a un cambio de escala de estas regiones metropolitanas, incrementándose la separación entre orígenes y destinos (Findlay et al., 2001) y por consiguiente las distancias de viaje por motivos laborales (Rouwendal y Rietveld, 1994) y discrecionales (Schwanen et al., 2001).

En estas emergentes Regiones Metropolitanas Multicéntricas (en adelante, RMM), la distancia a la metrópoli ha dejado de constituir el principal y único criterio de localización de hogares y centros de trabajo (Filion et al., 1999), cobrando mayor relevancia la proximidad a otros subcentros. Esta menor capacidad de polarización de la metrópoli en la atracción de flujos se traduce en un cambio en los patrones de movilidad, que si bien inicialmente se trataba de unas débiles relaciones fundamentalmente radiales (hacia la metrópoli) y desde localizaciones/sub-centros próximos al centro, se han complejizado, caracterizándose no solo por dichas relaciones centrípetas o de periferia-centro (que se han reforzado en intensidad y en área de atracción) sino además centrífugas (Giuliano y Gillespie, 1997) y tangenciales o de periferia-periferia (Clark y Kuijpers-Linde, 1994; Van der Laan, 1998). Sin embargo, interesa saber hasta qué punto estas nuevas relaciones funcionales más complejas y que han comenzado a caracterizar los territorios de las tradicionales áreas metropolitanas tienen lugar en áreas más alejadas de la metrópoli.

El trabajo pretende abordar cómo la influencia metropolitana y los procesos de re-escalamiento del Estado Nación, con la consiguiente creación de las diferentes comunidades autónomas y la emergencia de nuevas centralidades regionales como es el caso de las capitales de dichas autonomías, influyen en las dinámicas de movilidad de territorios distantes de RMM (aproximadamente entre 50-250 km desde la metrópolis). En este sentido la hipótesis de partida sostiene que con la descentralización política y económica en capitales regionales y provinciales, éstas empiezan a adquirir una mayor capacidad de polarización, teniendo lugar una redistribución de los flujos.

Para contrastar dicha hipótesis, se propone la Región Metropolitana Madrileña como caso de estudio, como buen ejemplo de la complejidad de los emergentes sistemas urbanos debido a los cambios que han acontecido durante las últimas décadas. Por un lado, procesos de dispersión, desconcentración y relocalización de población y actividades (Solís et al., 2012) apareciendo o reforzando nuevos subcentros metropolitanos que empiezan a adquirir un papel relevante en la organización de la región. Por otro, cambios en la movilidad (García-Palomares, 2010), asociados a un fuerte desarrollo de las infraestructuras de transporte, donde los tradicionales flujos principalmente atraídos por la metrópoli
han evolucionado hacia patrones más complejos y dispersos entre subcentros metropolitanos (Gallo et al., 2010).

El artículo se organiza en cuatro secciones dedicadas a la recopilación de estudios previos centrados en la compleja relación entre estructuras urbanas y relaciones funcionales, la presentación del caso de estudio, las fuentes de información y la metodología, la discusión de los resultados empíricos y las conclusiones.

2. LOS NUEVOS PATRONES URBANOS Y DE MOVILIDAD

Diversos académicos se han centrado en los cambios en las distancias o tiempos de viaje como consecuencia de los nuevos patrones urbanos policéntricos/dispersos (Cervero y Wu, 1998; Giuliano and Small, 1993; Gordon et al., 1991; Levinson, 1998) aunque sus conclusiones son contradictorias. Por otro lado, los estudios más recientes coinciden en que los emergentes modelos policéntricos han dado lugar a un aumento del commuting y de la dependencia del vehículo privado (Frost et al., 1998; García-Palomares, 2010; Ma and Banister, 2006) y que la “relocalización” cerca de los centros de empleo solo ocurre en determinados casos/para determinados grupos de población (Aguiléra, 2005). Por el contrario, atendiendo a diferentes motivos de viaje, Schwanen et al. (2001) concluyen que las distancias de viaje aumentan en modelos monocéntricos pero no necesariamente en los policéntricos. No obstante, la reorganización de los patrones de movilidad depende del tipo de subcentro, su tamaño y la proximidad a la metrópoli (Aguiléra y Mignot, 2004).

Esta compleja relación entre las relaciones funcionales y los patrones urbanos ha sido tema central en numerosos estudios, fundamentalmente analizada a través de flujos laborales/commuting (Castañer et al., 2000; Cervero, 1996; Clark and Kuijpers-Linde, 1994; Feria and Albertos, 2010; Reques et al., 2012; Sick and Harder, 2008), y tan solo un número reducido considera otros tipos de flujos menos recurrentes (Faulconbridge et al., 2009; Limtanakool et al., 2007a; Schwanen et al., 2001) puesto que tan solo representan una pequeña parte de la movilidad cotidiana (Nelson y Niles, 2000). En cualquier caso, puesto que el creciente aumento de la movilidad se debe en buena medida a un mayor número de desplazamientos no laborales (Ureña y Muruzábal, 2006) y debido a que los centros de trabajo han dejado de estar tan centralizados en un número reducido de centros, es creciente la relevancia de desplazamientos no obligados en los estudios de movilidad (Aguilera et al., 2009).

Entre dichos estudios centrados en el debate entre forma urbana y movilidad, pueden encontrarse fundamentalmente dos tipos de aproximaciones.

1. Por un lado, aquellos cuyo objetivo es entender el esquema de asentamientos a partir del análisis de flujos (intensidad y dirección) para diferentes motivos de viaje (Burger et al., 2011;
De entre ellos es de especial interés el análisis que Hall y Pain (2006) realizan de las relaciones funcionales de ocho “Mega-City Regions” europeas, prestando atención no solo a las ligazones entre ciudades para cada una de ellas sino además a la importancia relativa de estas ciudades en cada una de las regiones (en función de su conectividad a escala intra-regional y global). Sin embargo, se trata de un análisis estático. Otros dos estudios de movilidad similares diferenciando los viajes polarizados hacia la metrópoli, los existentes entre regiones periféricas o distantes así como los atraídos por estas han sido llevados a cabo para la cuenca parisina\(^1\) (Gilli, 2005\(^2\)) y el sureste de Inglaterra (de Goi\(\text{et al.}\), 2010\(^3\)).

2. Por otro, aquellos cuyo debate se centra en responder si los patrones de commuting se deben a la estructura urbana. En esta línea, Giuliano y Small (1993) concluyen que otros factores deben influir además del sistema de asentamientos puesto que los tiempos de viaje son superiores a los mínimos. Es por ello que estudios posteriores se han centrado en analizar el impacto de los desarrollos urbanísticos a una escala más local (Cervero and Kockelman, 1997; Boarnet and Sarmiento, 1998; Cervero 2002; Le Néchet, 2012) sobre los comportamientos de viaje, así como la influencia de otros aspectos socioeconómicos de la población (Titheridge and Hall, 2006; Van de Coevering and Schwanen, 2006) o la estructura de los hogares (Giuliano and Gillespie, 1997; McQuaid, 2009). Por su parte, con el fin de analizar las características de los nodos y su influencia sobre los patrones de movilidad, Limtanakool\(\text{et al.}\) (2007b) centran su investigación en analizar la posición de las ciudades dentro del sistema urbano atendiendo a un análisis de flujos (por motivos de negocio y de ocio) y de los atributos de los nodos (en relación a sus características socio-demográficas, accesibilidad, economía y turismo).

El presente artículo pretende completar los diversos estudios existentes sobre los emergentes modelos de movilidad asociados a las nuevas estructuras territoriales metropolitanas con un análisis diacrónico de las ligazones laborales (tanto frecuentes como por motivos de negocio) para territorios distantes de Regiones Metropolitanas Multicéntricas (entre 50 y 250 km aprox.), discerniendo entre los diferentes tipos de relaciones en función de su dirección, haciendo especial énfasis a las diferencias entre los flujos jerárquicos dirigidos a la metrópoli o a otros municipios regionales de alta centralidad (capitales regionales y provinciales). La originalidad de la temática radica en tratar de entender el rol de las capitales regionales de dichos territorios alejados recientemente transformados en regiones político-administrativas frente a la tradicional polarización de la metrópoli en la atracción de flujos. En definitiva, el debate se centra en analizar hasta qué punto el centro metropolitano continúa liderando los patrones de movilidad en dichos territorios distantes o si por el contrario nuevos flujos tangenciales comienzan a cobrar importancia.

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\(^{1}\) Espacio socio-económico bajo la influencia de París.
\(^{2}\) El análisis no considera otros motivos de viaje y diferentes escenarios temporales.
3. CASO DE ESTUDIO, METODOLOGÍA Y FUENTES DE INFORMACIÓN

3.1. EL TERRITORIO CASTELLANOMANCHEGO COMO CASO DE ESTUDIO

Los cambios en la estructura urbana en la Región Centro española han sido notables. Desde la década de los años 80, debido a la significativa inversión en el sistema de transportes y a los procesos de descentralización de la población y las actividades económicas, nuevos centros económicos y de empleo han comenzado a emergir en torno a Madrid, consolidándose una RMM (Solís, 2012). Como consecuencia, los procesos metropolitanos han comenzado a desbordar más allá de los propios límites administrativos de la provincia/región madrileña, dando lugar a fuertes interrelaciones funcionales con las provincias adyacentes (Burns et al., 2009; García-Palomares, 2010; Méndez y Rodríguez, 2007; Valenzuela, 2011).


Con el fin de analizar los patrones de movilidad y las emergentes centralidades en territorios distantes de RMM, el área de estudio (Figure 1 y Tabla 1) abarca las comunidades autónomas de Madrid y Castilla-La Mancha (en adelante, CLM). Consolidada en 1982 como región político-administrativa con Toledo como capital regional, CLM ha sido tradicionalmente considerada como un territorio
desorganizado, sin cohesión funcional y acefálico, notablemente influído por Madrid (Cebrián y Cebrián, 2000).

El carácter de paso del sistema de transporte de CLM ha sido un condicionante clave en la dinámica urbana regional y a pesar de las mejoras de transporte de las últimas décadas, que han comenzado a transformar la tradicional red de ferrocarril y carreteras, predominantemente radial, en otra radioconcentrada en torno a la metrópoli aunque en el territorio castellano-manchego las infraestructuras continúan siendo proyectadas bajo lógicas nacionales conectando la región con Madrid. En cuanto a la red de carreteras, los principales cambios que han tenido lugar en el área de estudio han sido principalmente tres: a) la adecuación (o duplicación) de las carreteras nacionales a los estándares de autovía en todo el área de estudio, reduciendo considerablemente los tiempos de viaje (ver Tabla 2); b) la construcción de cuatro nuevas autovías orbitales/semi-orbitales en la provincia/región madrileña (M-30, M-40, M-45 and M-50); c) construcción de tres tramos de autovía tangenciales (CM-42, A-43 and A-40) en CLM. En cuanto a la red ferroviaria, los cambios han consistido en la reducción del número de servicios de la red convencional, la ampliación del ferrocarril suburbano/cercanías más allá de los límites de la región madrileña y la creación de la red de Alta Velocidad entre cada una de las provincias de CLM y Madrid1.

La mayor parte de los estudios de movilidad en la Región Centro española han limitado sus análisis a territorios cercanos a la metrópoli, aproximadamente a unos 50 km en torno a ella (Gallo et al., 2010; García-Palomares, 2010; Gutiérrez-Puebla and García-Palomares, 2007) y tan solo una minoría considera áreas más alejadas (Pillet et al., 2010; Solís et al., 2012). Por otro lado, debido a la falta de datos de movilidad actualizados/recientes, principalmente se han limitado a analizar la evolución de ligazones laborales para un período de veinte años (1981-2001). Por ello, el presente artículo pretende ir más allá, tratando de analizar la evolución hasta la situación actual (1981-2012) no solo de los viajes de commuting sino de un tipo de viaje que comienza a cobrar especial importancia en los patrones de movilidad obligada, los viajes de negocio, y cubriendo un territorio más distante del hasta hora considerado en este tipo de estudios.

3.2. METODOLOGÍA

El presente análisis de articulación territorial se aborda desde una doble perspectiva.

1. Por un lado, atendiendo a la evolución de los patrones de commuting ocurridos en las tres últimas décadas (1981-2001-2012). En primer lugar, en términos absolutos (número de viajes

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1 Existen tres conexiones tangenciales regionales de alta velocidad ferroviaria: CR-Cuenca (un único Servicio por día y dirección). Cuenca-Albacete y CR-Puertollano (no relevante desde el punto de vista de relaciones horizontales debido a la reciente autovía que conecta igualmente ambos municipios).
originados en cada municipio) con el fin de identificar aquellos centros del sistema de ciudades liderando los patrones de movilidad regional (desde el punto de vista de la intensidad de la interacción). En segundo lugar, en términos relativos (como el porcentaje de desplazamientos intermunicipales que desde un municipio se dirigen a un determinado destino) con el fin de entender la reconfiguración de la centralidad de los diferentes destinos.

2. Por otro, caracterizando los patrones regionales de desplazamientos por motivos de negocio, comparando su estructura con la de commuting y analizando la evolución de dichas relaciones de negocio (2006-2012) para la provincia de Ciudad Real.

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<td>(Hab.) (%)</td>
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<td>Albacete (Capital)</td>
<td>117.126 (35)</td>
<td>149.507 (41)</td>
<td>172.472 (43)</td>
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<td>143.449 (39)</td>
<td>147.146 (37)</td>
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<td>367.283 (100)</td>
<td>402.837 (100)</td>
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<td>Ciudad Real (Capital)</td>
<td>51.118 (11)</td>
<td>61.280 (13)</td>
<td>74.921 (14)</td>
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<tr>
<td>Resto de la provincia de Ciudad Real</td>
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<td>284.959 (60)</td>
<td>301.035 (57)</td>
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<td><strong>Total Provincia Ciudad Real</strong></td>
<td>468.327 (100)</td>
<td>478.581 (100)</td>
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<td>Cuenca (Capital)</td>
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<td>46.491 (23)</td>
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<td>167.207 (80)</td>
<td>155.035 (77)</td>
<td>161.004 (74)</td>
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<td><strong>Total Provincia Cuenca</strong></td>
<td>208.998 (100)</td>
<td>201.526 (100)</td>
<td>218.036 (100)</td>
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<td>Guadalajara (Capital)</td>
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<td>67.640 (39)</td>
<td>84.803 (33)</td>
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<td>Otros municipios &gt; 20.000 hab. [Nº]</td>
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<td>20.383 [1] (12)</td>
<td>35.146 [1] (14)</td>
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<td>Resto de la provincia de Guadalajara</td>
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<td>83.509 (49)</td>
<td>139.588 (54)</td>
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<td>Total Región Castilla La Mancha</td>
<td>1.588.618 (100)</td>
<td>1.755.053 (100)</td>
<td>2.121.888 (100)</td>
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**Tabla 1.** - Evolución de la población de las provincias y capitales de Castilla La Mancha (1981-2012). **Fuente:** Censos de Población y Viviendas de 1981 y 2001 y Padrón municipal de 2012 (INE).
Para cada uno de los municipios, se prestará especial atención a las relaciones intermunicipales determinantes, definidas como aquellas con más de 50 ligazones y en las que los desplazamientos intermunicipales representan más del 10% de la población ocupada desplazada. De entre ellas, se distinguirá igualmente entre la relación con el mayor número de desplazamientos (primaria) del resto (secundarias).

Con el fin de caracterizar la capacidad de polarización de las principales centralidades de RMM, en estos análisis se discretizarán las relaciones funcionales en función del tipo de destino, distinguiendo entre:

a. Relaciones intraprovinciales jerárquicas: desplazamientos intermunicipales con destino la capital de la provincia de residencia.

b. Relaciones intraprovinciales no jerárquicas: desplazamientos intermunicipales con destino otro municipio de la provincia de residencia (excluyendo la capital).

c. Relaciones intraprovinciales totales, como suma de los dos tipos de flujo anteriores, es decir, desplazamientos intermunicipales con destino otro municipio de la provincia de residencia.

b. Relaciones tangenciales jerárquicas: desplazamientos intermunicipales con destino la capital regional (en el caso del área de estudio, Toledo).

e. Relaciones tangenciales no jerárquicas: desplazamientos intermunicipales con destino otras provincias castellanomanchegas (excepto al municipio de Toledo).

f. Relaciones tangenciales totales, como suma de los dos tipos de flujo anteriores, es decir, desplazamientos intermunicipales con destino otro municipio regional (de una provincia diferente a la de residencia).

g. Relaciones radiales jerárquicas: desplazamientos intermunicipales con destino el municipio de Madrid.

### Tabla 2. Evolución de los tiempos de viaje por carretera entre las principales ciudades de Madrid y Castilla La Mancha. (Años 1981-2012). Fuente: elaboración propia.

<table>
<thead>
<tr>
<th>Ciudad Real</th>
<th>Cuenca</th>
<th>Guadalajara</th>
<th>Madrid</th>
<th>Toledo</th>
</tr>
</thead>
<tbody>
<tr>
<td>134 (min)</td>
<td>112 (min)</td>
<td>192 (min)</td>
<td>151 (min)</td>
<td>156 (min)</td>
</tr>
<tr>
<td>145 (min)</td>
<td>159 (min)</td>
<td>132 (min)</td>
<td>80 (min)</td>
<td></td>
</tr>
<tr>
<td>83 (min)</td>
<td>99 (min)</td>
<td>117 (min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>34 (min)</td>
<td>80 (min)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47 (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
h. Relaciones radiales no jerárquicas: desplazamientos intermunicipales con destino con otros municipios madrileños (excluyendo Madrid).

i. Relaciones radiales totales, como suma de los dos tipos de flujo anteriores, es decir, desplazamientos intermunicipales con destino otro municipio de la provincia madrileña.

j. Relaciones inter-regionales: desplazamientos intermunicipales hacia otras regiones españolas, excepto la madrileña.

k. Relaciones internacionales: desplazamientos intermunicipales hacia otros países.

3.3. FUENTES DE INFORMACIÓN

Las estadísticas del Instituto Nacional de Estadística (INE), y en concreto los Censos de Población y Vivienda de 1981 y 2001 y su información referente a la movilidad laboral/desplazamientos residencia-trabajo, conforman una de las principales fuentes de datos empleadas. A pesar de que el Censo de 1981 incluía en su cuestionario una pregunta referente al municipio de trabajo/estudio, la información recogida presenta algunos problemas o carencias, como el ocurrido a la hora de llevar a cabo su explotación (tan solo se dispone de información desagregada de los desplazamientos hacia municipios de más de 20.000 habitantes), lo cual ha limitado de manera significativa su utilización. El Censo de 2001, es el más novedoso y fructífero de la historia censal del país, ya que introduce un gran número de respuestas y un cruce de numerosas variables con la posibilidad de obtener un perfil de la población más riguroso. Este Censo recoge en su cuestionario una pregunta referente al lugar de trabajo de la población mayor de 16 años, diferenciando cinco categorías: aquellos que trabajan/estudian en el propio domicilio, en el mismo municipio, en varios municipios (transportistas, representantes, etc), en otro municipio (identificando cuál) o en otro país. Esta fuente introduce el concepto de población vinculada que es definida como el conjunto de personas censales (residentes en España) que tienen algún tipo de vinculación con el municipio en cuestión (ya sea por residencia, trabajo o estudios).

Sin embargo, uno de los retos de la presente investigación es la falta de información estadística pública accesible y actualizada a escala supra-metropolitana para el caso de desplazamientos obligados de commuting (no disponible en el área de estudio desde 2001). En cuanto a los viajes por motivos de negocio, dicha información tan solo se encuentra disponible para una de las provincias (Ciudad Real) y para los escenarios de 1980 y 2006 a través de las encuestas realizadas por las investigaciones de Pillet et al. (1980) y Garmendia et al. (2011). Por ello, surge la necesidad de llevar a cabo una encuesta de movilidad de los hogares regionales, diseñada, realizada y explotada por los propios autores, con el fin entender los patrones de desplazamientos en 2012.

Por tratarse de un territorio muy extenso (79.463 km²) y alta población (2.121.888 hab en 2012), la realización de encuestas con una distribución homogénea, fue descartada desde un primer momento, debido a la imposibilidad técnica en términos de recursos humanos y económicos necesarios para llevar
a cabo la recogida y el tratamiento de la información, así como de su duración. La metodología empleada a la hora de escoger la muestra consistió en dirigir los cuestionarios a un sector específico de la población siguiendo una metodología probada con anterioridad y cuyos resultados permitieron establecer conclusiones relevantes en los patrones de movilidad (Pillet, 1980; Garmendia et al., 2011). Se trata de “organizar una estructura de distribución y recogida de los cuestionarios en forma de árbol” (Pazos, 2005) con una serie de personas clave de contacto directo, que a su vez harían llegar las encuestas al total de la muestra. Se seleccionó distribuir los cuestionarios entre los alumnos de Educación Secundaria Obligatoria y Bachillerato. A pesar del sesgo producido al considerar únicamente un determinado grupo de población (familias con hijos en edad escolar), este sector presenta altos niveles de movilidad (Schwanen et al., 2001) haciéndolo más atractivo para el estudio (Pazos, 2005).

Una vez definida la metodología, los municipios a los que dirigir el cuestionario (un total de 20) fueron seleccionados (ver Figura 1) según los siguientes criterios:

- a. Su localización geográfica con el fin de alcanzar un conjunto de puntos de contacto homogéneamente distribuidos por el territorio regional;
- b. Su tamaño en términos de población y la existencia de, al menos, un instituto de Educación Secundaria Obligatoria;
- c. Una dinámica demográfica positiva durante los últimos treinta años (1981-2012) y
- d. Su capacidad de articular/organizar los territorios adyacentes

El tamaño de la muestra se calculó para un margen de error del 7% y un nivel de confianza del 95%. Un total de 7.345 encuestas fueron completadas y recibidas, de las cuales se rescataron 6.913 encuestas válidas, cumpliendo con los objetivos de representatividad de la muestra fijados.

El cuestionario se elabora en torno a dos bloques: uno primero más general, enfocado a caracterizar el hogar y en concreto, al cabeza de familia encuestado, y un segundo que tiene un carácter más detallado y cuya finalidad es obtener información de los desplazamientos. En este segundo bloque se distinguen además dos partes. Una primera destinada a los desplazamientos del cabeza de familia (tanto por motivos de trabajo como por relaciones de negocio con municipios diferentes al de residencia) y por otro, del resto de miembros de la unidad familiar que se desplazan a diario al centro de trabajo a otro municipio diferente al de residencia. La segunda parte del bloque hace referencia al resto de posibles desplazamientos en función de distintos motivos de viaje (compras, sanitario, ocio, etc.). Los análisis presentados en este artículo se centran únicamente en la información recogida en el primer bloque, esto es, en los desplazamientos por motivos laborales: de commuting (entendidos como los desplazamientos frecuentes entre el lugar de residencia y el lugar de trabajo) y de negocio (entendidos como aquellos viajes que por motivos laborales tienen un carácter menos recurrente que los de commuting, como por ejemplo para visitar a un cliente, participar en una conferencia o asistir a una reunión).
4. RESULTADOS EMPÍRICOS: HACIA LA MULTIDIRECCIONALIDAD DE LOS FLUJOS LABORALES

Tal y como se ha mencionado anteriormente, el objetivo del presente estudio es, centrándose en las ligazones laborales, tratar de esclarecer si la complejidad de los emergentes modelos urbanos (policéntricos) así como de los patrones de movilidad en entornos cercanos de áreas metropolitanas, también caracteriza territorios más distantes de RMM. Para ello no solo serán significativos los flujos diarios por motivos de trabajo (commuting) sino además las relaciones de negocios, las cuales comienzan a ser cada vez más frecuentes (Urry, 2003). El interés en prestar atención a ambos motivos de viajes laborales radica en que los últimos pueden reorganizarse espacialmente con mayor rapidez y son más flexibles que los de commuting (Burger et al., 2011), lo cual podría ser un indicador de futuras reorganizaciones espaciales.

4.1. NOTABLE AUMENTO Y MAYOR MULTIDIRECCIONALIDAD DE LOS PATRONES DE COMMUTING.

4.1.1. Incremento de la movilidad

Los flujos de commuting intermunicipales han aumentado notablemente tanto en intensidad (número de desplazamientos en las diferentes relaciones) como en área de influencia (número de destinos) entre 1981 y 2012 (Figure 2.a. y Tabla A), multiplicándose los de 1981 entre 2 y 10 veces en 2001 y entre 3 y 20 veces en 2012 (Tabla 3). Este incremento notable, mayor que el ya descrito para el caso nacional (Castañer et al., 2000), podría ser debido a motivos generales como la duplicación tanto de los niveles de motorización\(^1\) como de la incorporación de la mujer al mercado laboral\(^2\), pero además a las considerables reducciones en los tiempos de viaje favorecidas por la mejora de las infraestructuras (en torno a un 20%,Tabla 2) en CLM así como a la progresiva integración de dicha región en los procesos metropolitanos.

En este sentido, entre 1981 y 2012, las relaciones de commuting intraprovinciales (por lo general mayores hacia las capitales provinciales\(^3\)) y radiales (generalmente mayores hacia Madrid\(^4\)) han aumentado considerablemente (Tabla 3 y Tabla A). En el caso de las interacciones radiales, este

\(^1\) De 0.28 veh/persona en 1981 a 0.67 veh/persona en 2011 (DGT, 2008 y 2011).
\(^2\) De 26.8% en 1981 (Martín, 2000) a 52.9% en 2002 (INE, 2011).
\(^3\) 10 de 15 municipios encuestados (excluyendo las cinco capitales) entre 1981 y 2001, y 11 de 15 entre 2001 y 2012, tienen mayores incrementos de dichas relaciones intraprovinciales hacia sus respectivas capitales provinciales que hacia el resto del territorio provincial.
\(^4\) La mayoría de los flujos radiales hacia otros subcentros metropolitanos se originan en municipios cercanos a los límites administrativos de la Comunidades Autónomas (Fig.2.a). En 2001 y 2012, 18 de los 20 municipios encuestados tuvieron una mayor interacción con Madrid que con otros subcentros metropolitanos. Solo aquellos municipios más cercanos a los límites regionales (< 15 km) y a otras ciudades madrileñas (con una población superior a 50,000 habitantes) presentan mayores interacciones con subcentros metropolitanos adyacentes.
crecimiento fue más significativo entre 1981 y 2001, momento en el que otros municipios madrileños comenzaron a adquirir un papel de subcentros metropolitanos.

Desde el punto de vista de los flujos tangenciales hacia Toledo, mientras que este tipo de relación no existía en 1981 (Figure 2.a y Tabla A), gracias a su designación como capital regional de CLM en 1982, comienzan a aparecer en 2001, excepto para los municipios de la provincia de Guadalajara (más cercanos a Madrid). En 2012, la reducción de los tiempos de viaje como consecuencia de la construcción de la nueva autovía CM-42, ha tenido un notable impacto en las relaciones hacia Toledo, aumentando desde el área central de CLM (Alcázar de San Juan, Tarancón and Villarrobledo). En 2001 y 2012, los municipios que presentan una mayor interacción con la capital regional en términos absolutos (número de desplazamientos) son las otras cuatro capitales de provincia.

Por el contrario, en cuanto al resto de flujos tangenciales, aunque con una intensidad muy débil, ya existían en algunos municipios (doce de veinte encuestados) en 1981 (Figure 2.a y Tabla A). En 2001, todos los municipios encuestados mostraban este tipo de relación, aumentando en 2012 para la mayoría de ellos (quince de veinte municipios) (Figure 2.a y Tabla A). En este sentido, esta multinodalidad de los patrones de movilidad sostiene nuestra hipótesis de partida y por tanto se podría concluir que nuevas centralidades están emergiendo en la región castellanomanchega.

De manera similar, las relaciones hacia otros territorios nacionales eran débiles en 1981 (Figure 2.a y Tabla A), más significativas en aquellos territorios más distantes de Madrid (en concreto los municipios del este, tradicionalmente más relacionados con las áreas metropolitanas del levante español). El período entre 1981 y 2001 se caracteriza por un incremento generalizado de este tipo de flujos, mientras que entre 2001 y 2012, se produce una reorganización, incrementando para las dos capitales más distantes a Madrid (Albacete y Cuenca) y decreciendo en las otras tres provincias (Figure 2.a).

Centrándonos en los flujos determinantes para el escenario de 2012 (Figure 2.b.), que han incrementado progresivamente en las últimas tres décadas, se observa que los principales nunca han sido tangenciales hacia Toledo, siendo en la mayoría de los casos radiales hacia Madrid. Las únicas excepciones se dan en:

1. Municipios a menos de 60 km de su capital provincial, donde los flujos jerárquicos hacia dichas capitales son los principales.

2. Municipios de baja centralidad cercanos a los límites provinciales y a municipios de otras provincias de mayor centralidad, donde los flujos tangenciales son significativos.

3. Municipios distantes de Madrid (más de 200 km) donde las relaciones intraprovinciales jerárquicas hacia la capital son las principales. Mientras que estos municipios no presentan flujos determinantes principales hacia la región madrileña, en algunos casos sí que presentan relaciones determinantes secundarias hacia Madrid u otras regiones españolas.

<table>
<thead>
<tr>
<th>Municipio</th>
<th>Distancia a Madrid (km)</th>
<th>Incremento del total de relaciones radiales (2012-2001)</th>
<th>Incremento del total de relaciones tangenciales (2012-2001)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anzures de Henares</td>
<td>47.6</td>
<td>1.6</td>
<td>2.0</td>
</tr>
<tr>
<td>Bartolomé</td>
<td>19.2</td>
<td>2.9</td>
<td>1.1</td>
</tr>
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<td>29.2</td>
<td>2.7</td>
<td>1.9</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>58.1</td>
<td>2.1</td>
<td>1.7</td>
</tr>
<tr>
<td>Ocaña</td>
<td>46.0</td>
<td>2.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Toledo</td>
<td>74.2</td>
<td>1.3</td>
<td>1.1</td>
</tr>
<tr>
<td>Tarancón</td>
<td>82.2</td>
<td>1.5</td>
<td>1.4</td>
</tr>
<tr>
<td>Terreras</td>
<td>62.2</td>
<td>1.5</td>
<td>2.0</td>
</tr>
<tr>
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<td>121.1</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>Salamanca</td>
<td>125.1</td>
<td>1.1</td>
<td>1.3</td>
</tr>
<tr>
<td>Talavera de la Reina</td>
<td>128.0</td>
<td>1.1</td>
<td>1.1</td>
</tr>
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<td>Sigüenza</td>
<td>129.8</td>
<td>1.2</td>
<td>1.2</td>
</tr>
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<td>0.9</td>
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<td>150.8</td>
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<td>1.2</td>
<td>1.2</td>
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<td>Villaverde</td>
<td>203.1</td>
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<td>1.0</td>
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<tr>
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<td>210.9</td>
<td>1.0</td>
<td>1.0</td>
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<td>0.8</td>
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<td>0.6</td>
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<td>0.4</td>
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<tr>
<td>Almassora</td>
<td>324.9</td>
<td>0.2</td>
<td>0.2</td>
</tr>
</tbody>
</table>

*No se han registrado flujos de este tipo en 1981;** Los incrementos sustanciales pueden haberse debido a la construcción de la línea de Alta Velocidad Madrid-Valencia (1992) con estaciones en estos municipios.
* La información desagregada en 1981 tan solo se encuentra disponible para los municipios de más de 20.000 habitantes.

La información desagregada en 1981 tan solo se encuentra disponible para los municipios de más de 20.000 habitantes.

<table>
<thead>
<tr>
<th>Municipio</th>
<th>Población 2012 (Hab.)</th>
<th>Distancia a Madrid (km)</th>
<th>Motivo de viaje</th>
<th>Relaciones por motivos de commuting</th>
<th>Rel. motivos de negocios 2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azuqueca de Henares</td>
<td>35.146</td>
<td>47,6</td>
<td>1º 2º 3º 4º</td>
<td>1º 2º 3º 4º</td>
<td>1º 2º 3º 4º</td>
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<tr>
<td>Casar (El)</td>
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<td>55,1</td>
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<td>56,8 43,2 0,0 0,0</td>
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<tr>
<td>Guadalajara</td>
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<td>58,1</td>
<td>70,3</td>
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<td>45,3 2,5 0,2 34,7</td>
</tr>
<tr>
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<td>64,0</td>
<td>50,0</td>
<td>50,0 0,0 0,0 0,0</td>
<td>52,9 42,0 2,7 2,4</td>
</tr>
<tr>
<td>Toledo</td>
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<td>74,2</td>
<td>65,1</td>
<td>20,5 12,1 2,1 63,0</td>
<td>29,7 4,2 3,1 50,7</td>
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<tr>
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<td>51,7</td>
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<tr>
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<td>86,8</td>
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<tr>
<td>Cuenca</td>
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<td>Valdepeñas</td>
<td>31.212</td>
<td>203,1</td>
<td>83,1</td>
<td>13,8 1,3 0,0 64,9</td>
<td>18,4 11,6 5,2 73,0</td>
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<tr>
<td>Villarrubio</td>
<td>26.583</td>
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<td>22,0 20,0 11,0 34,3</td>
<td>25,4 23,1 17,2 33,3</td>
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<td>74,5</td>
<td>21,7 3,8 0,0 61,4</td>
<td>38,9 4,5 3,2 47,5</td>
</tr>
</tbody>
</table>

En cuanto a los flujos determinantes secundarios en 2012 (Figure 2.b.) en la mayoría de los casos son jerárquicos hacia la capital provincial o radiales hacia Madrid, y tan solo en dos municipios en el centro de la región son hacia otros territorios regionales. En cuanto a los flujos determinantes secundarios radiales hacia otros subcentros madrileños, únicamente tienen lugar desde municipios cercanos (aunque durante las tres últimas décadas el área de influencia comienza a cubrir un mayor número de municipios).

4.1.2. Hacia la multidireccionalidad

Además de prestar atención a la intensidad de los flujos, es fundamental el peso relativo que cada tipo de relación representa sobre el total de las ligazones de commuting generadas desde ese municipio (Tabla 4) para entender si las centralidades que comienzan a emerger (nuevos destinos de desplazamiento) están reorganizando los patrones de movilidad.

En 1981, los flujos de commuting intermunicipales eran principalmente radiales e intraprovinciales y tan solo dos de los municipios encuestados en 2012 presentaban una notable interacción (superior al 20%) con otros territorios regionales. Este papel fundamental ejercido por los destinos de la misma provincia de residencia ha continuado caracterizando la movilidad laboral en las siguientes décadas. Sin embargo, en 2001 las relaciones radiales comenzaron a adquirir importancia (trece municipios aumentaron su interacción con otros municipios madrileños mientras que sus relaciones tangenciales disminuyeron), perdiendo relevancia en 2012. Esta menor polarización de los municipios madrileños como principal destino de commuting refuerza nuevamente nuestra hipótesis de partida, concluyéndose que dentro del territorio castellanomanchego nuevas centralidades han comenzado a emerger y comienzan a ejercer un papel crucial en la atracción de flujos. En este sentido es importante matizar que esta menor polarización no significa un menor número de desplazamientos hacia la provincia de Madrid (ya que como se ha señalado en el apartado anterior, entre 1981 y 2012 las relaciones de commuting radiales han aumentado considerablemente en términos absolutos), sino que debido a la creación de la capitalidad regional en Toledo que ha generado sus propios flujos de atracción, teniendo lugar una redistribución de las ligazones laborales.

Prestando atención únicamente a los flujos hacia otras provincias diferentes a la de residencia (extra-provinciales), en 1981 podrían establecerse dos patrones. Por un lado, los municipios más cercanos a la metrópoli, donde la atracción de la región madrileña era predominante. Por otro, municipios más alejados/periféricos, que presentan una mayor vinculación hacia otras regiones españolas. En 2001, a pesar del cambio de escala en el área de atracción de la región madrileña (cubriendo un territorio más amplio/alejado) y del refuerzo de las relaciones existentes en los municipios más cercanos a Madrid, las ligazones laborales tangenciales comienzan a ganar importancia. En 2012, el territorio donde la influencia de Madrid es sustancial/principal (frente al resto de relaciones) abarca unos 130 km (y tan solo en unos pocos municipios algo más alejados de la metrópoli, en cuyo...
caso se han visto favorecidos por la Alta Velocidad Ferroviaria), mientras que para municipios más distantes las relaciones tangenciales adquieren un papel principal sobre el resto.

En definitiva, atendiendo a la importancia relativa de las relaciones inter-municipales, se observan dos tendencias (ver Figura 3). La primera, en el período 1981-2001, donde Madrid refuerza su papel como principal atractor de flujos extraprovinciales, tanto para los municipios más cercanos como para los más alejados. La segunda, durante la última década, caracterizada por un debilitamiento del papel polarizador de Madrid junto con un refuerzo de las relaciones tangenciales (aunque todavía débiles y solo para un reducido número de municipios cercanos la zona central/centro geográfico/de gravedad de CLM), dando lugar a unos patrones de movilidad más complejos.

4.2. PATRONES ESPACIALES DE LOS VIAJES DE NEGOCIOS

El análisis diacrónico de los viajes de negocios de la provincia de Ciudad Real para 2006 y 2012 revela igualmente la consolidación de unos patrones de movilidad más complejos debidos a la diversificación de los destinos. En ese sentido, mientras que en 2006 las relaciones radiales e intraprovinciales hacia cada capital (35,0% y 21,0%, respectivamente) presentaban una mayor intensidad que las tangenciales hacia Toledo (6,0%) y las intra-regionales (Garmendia et al., 2011), en 2012, aunque los dos primeras continúan siendo principales, redujeron su atracción a la mitad (19,0% y 8,4%, respectivamente), aumentando por otro lado las ligazones tangenciales hacia Toledo en un tercio (a 9,4%), haciéndose igualmente más significativos los flujos hacia el resto del territorio regional (8,4%) y nacional (19,4%).

Por otro lado, comparando los patrones regionales de commuting y negocios para el año 2012, tres conclusiones principales pueden extraerse (Figure 41). En primer lugar, que las relaciones de negocios tienen lugar con territorios más alejados. En segundo, que las relaciones de negocios son menos complejas ya que los flujos se dirigen hacia un reducido número de destinos de alta centralidad (principalmente Madrid y en menor medida, las capitales de provincia). Y finalmente, que el total de relaciones tangenciales por motivos de negocio son claramente superiores a las que se producen por motivos de commuting (ver Tabla 4 y Figura 4).

---

1 Puesto que los flujos por motivos de negocio son menos frecuentes que los de commuting y un menor número de trabajadores viajan por este motivo, con el fin de mostrar una imagen precisa de la situación actual, los límites para identificar los flujos determinantes se han reducido a 50 trabajadores y 5% de la población desplazada en cada municipio.
5. CONCLUSIONES

El presente artículo complementa los recientes estudios sobre RMM mediante un análisis de sus territorios distantes, tratando de entender si la complejidad de los patrones de movilidad en entornos próximos a la metrópoli (40-50 km, aprox.) igualmente caracteriza los patrones de relaciones funcionales de territorios más alejados (hasta unos 250 km).

Por otro lado, cabría señalar que aunque el artículo aborda el caso de estudio de la RMM madrileña, las conclusiones extraídas son útiles para sistemas urbanos de Regiones Metropolitanas que progresivamente amplían sus límites y comienzan a sufrir transformaciones hacia modelos más multicéntricos (aunque la metrópoli sigue ejerciendo un papel principal en la organización del territorio y la atracción de flujos). No obstante, la generalización de las conclusiones aquí extraídas dependerá en cierta medida del tamaño poblacional y la proximidad de las capitales regionales al centro metropolitano.

Los resultados empíricos muestran que estas áreas distantes han aumentado de manera notoria sus flujos laborales hacia otros municipios, siendo estos además más complejos. Esta mayor complejidad genera nuevas relaciones, además de las tradicionales hacia la capital provincial: tangenciales entre
territorios de estas áreas distantes, radiales hacia la tradicional área metropolitana e interregionales con otras regiones españolas.

Sin embargo, estos nuevos patrones multicéntricos de las relaciones intermunicipales de territorios distantes de RMM están mucho menos desarrollados que los de las áreas más próximas. Es decir, a pesar de que nuevas relaciones horizontales están emergiendo entre municipios distantes de la metrópoli (más significativos para los flujos de negocios), la redistribución de desplazamientos hacia patrones más complejos caracterizando áreas metropolitanas con un nivel de articulación elevado, no son tan evidentes para territorios distantes donde los flujos son principalmente jerárquicos, bien hacia la capital provincial y hacia la metrópoli.

No obstante, diferentes patrones espaciales comienzan a aparecer y pueden ser identificados en estas áreas distantes:

1. Municipios próximos a la metrópolis, como son Azuqueca de Henares, El Casar, Ocaña o Tarancón para el caso de Castilla-La Mancha, mantienen o aumentan sus flujos radiales, siendo los únicos municipios con una cierta vinculación con otros subcentros metropolitanos.

2. La capacidad de polarización de la metrópolis se traduce en que hasta una determinada distancia (en el caso madrileño, en torno a 150 km) los desplazamientos radiales son más intensos que los jerárquicos hacia las capitales provinciales.

3. A pesar de que las nuevas capitales regionales consolidadas en estos territorios distantes y las infraestructuras de transporte están facilitando la lenta aparición de nuevas relaciones tangenciales (generando patrones de movilidad más complejos), la mayor parte de los flujos determinantes principales continúan siendo radiales o jerárquicos hacia los tradicionales centros más próximos. La relevancia de los flujos intraprovinciales en áreas distantes pone de manifiesto el débil desarrollo de estructuras policéntricas a nivel intra-regional, donde cada capital provincial continúa ejerciendo una influencia significativa, y tan solo un número limitado de viajes (aunque en aumento) tiene lugar con otros territorios más allá de los límites administrativos de cada provincia. Tan solo para el caso de desplazamientos por motivos de negocio, las capacidades de atracción de las nuevas capitales regionales, como es Toledo para el caso de Castilla-La Mancha, pueden ser comparadas con las de los centros metropolitanos, como es Madrid en el caso de estudio, llegando a igualar e incluso superar el total de los radiales. Para los desplazamientos laborales, esta polarización de las capitales regionales no llegan a alcanzar las de la metrópoli (algo que podría deberse al corto período de treinta años transcurrido desde la consolidación de las autonomías españolas y la designación de las capitales regionales).

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2 Estos resultados coinciden con los concluidos por de Goei et al. (2010) y Solís et al. (2012).
4. Aquellos municipios con mayor centralidad (tamaño, presencia de administración pública, servicios públicos, actividades económicas, etc), como son Albacete, Ciudad Real, Guadalajara o Cuenca en el caso de Castilla-La Mancha, tienden a desarrollar un rol de intermediación, atrayendo un porcentaje importante de flujos desde municipios de centralidad menor y por el contrario, sus flujos intermunicipales comienzan a tener lugar cada vez más con la metrópolis y otros municipios de su misma centralidad.

En definitiva, tres sub-áreas pueden distinguirse en estos territorios distantes de RMM:

1. Una primera corona a una cierta distancia de la metrópolis donde las relaciones radiales son de gran intensidad.

2. Una zona a una distancia media del centro metropolitano con fuertes relaciones tangenciales, llegando a ser tanto o más importantes que las radiales.

3. Un sub-área compuesta por los municipios más distantes con fuertes interacciones hacia otras áreas urbanas periféricas.

Finalmente, en relación a la metodología, el artículo muestra las especificidades de territorios distantes de regiones metropolitanas y confirma que la realización de encuestas a un número determinado de municipios podría ser suficiente para entender sus patrones de movilidad. No obstante, puesto que los resultados apuntan que determinados municipios presentan diferentes relaciones espaciales, las encuestas llevadas a cabo en un futuro deberían prestar mayor atención a estos distintos tipos de municipios. En concreto a los siguientes tres tipos: municipios próximos al tradicional área metropolitana, municipios con alta centralidad y municipios con baja centralidad, tanto en zonas centrales de la región como en zonas más distantes.

<table>
<thead>
<tr>
<th>(Provincia)</th>
<th>ALBACETE</th>
<th>CIUDAD REAL</th>
<th>CUENCA</th>
<th>GUADALAJARA</th>
<th>TOLEDO</th>
</tr>
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<tbody>
<tr>
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<td>AL</td>
<td>VI</td>
<td>CR</td>
<td>AJ</td>
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<td>58</td>
<td>55</td>
<td>53</td>
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</tr>
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<td>Intraprovincial (horizontal) (2)</td>
<td>588</td>
<td>322</td>
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<th>(Provincia)</th>
<th>ALBACETE</th>
<th>CIUDAD REAL</th>
<th>CUENCA</th>
<th>GUADALAJARA</th>
<th>TOLEDO</th>
</tr>
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<td>AB</td>
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<td>CR</td>
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<td>Intraprovincial (vertical) (1)</td>
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<td>Intraprovincial (horizontal) (2)</td>
<td>588</td>
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CHANGING ACCESSIBILITY AND MOBILITY PATTERNS IN RECONFIGURED RURAL METRO-ADJACENT REGIONS

BIBLIOGRAFÍA


MOHINO, I., 2015
CHANGING ACCESSIBILITY AND MOBILITY PATTERNS IN RECONFIGURED RURAL METRO-ADJACENT REGIONS


[303]
APPENDIX VII

Paper 2’s additional information

MOHÍNO, I., SOLÍS, E. & UREÑA, J.M. (Mimeo) Changing Commuting Patterns in Rural Metro-Adjacent Regions: The case of Castilla-La Mancha (Spain).

Submitted to Regional Studies (Accepted with minor revisions).
### APPENDIX VII – PAPER 2’s additional information

"Changing Commuting Patterns in Rural Metro-Adjacent Regions: the case of Castilla-La Mancha (Spain)"

#### Table A.VII.1. - Out-commuting linkages of Castilla-La Mancha working population. Source: authors based on 1981, 2001 and 2011 Censuses (INE).

<table>
<thead>
<tr>
<th>Year</th>
<th>Municipality</th>
<th>Population (% of total CLM pop.)</th>
<th># total out-commut. flows (% out of working population)</th>
<th>Share of out-commuting flows directed towards:</th>
<th>(Regional level)</th>
<th>(Municipal level)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Madrid Region (1)</td>
<td>CLM (1)(2)</td>
<td>Other Region (1)</td>
<td>Madrid</td>
</tr>
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<td>1981</td>
<td>Albacete</td>
<td>117,126 (7.2%)</td>
<td>1,012 (3.2)</td>
<td>6.3</td>
<td>64.6</td>
<td>29.1</td>
</tr>
<tr>
<td></td>
<td>Alcázar S. Juan</td>
<td>25,185 (1.5%)</td>
<td>206 (2.9)</td>
<td>19.4</td>
<td>73.8</td>
<td>6.8</td>
</tr>
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<td></td>
<td>Tomelloso</td>
<td>26,655 (1.6%)</td>
<td>313 (4.1)</td>
<td>41.2</td>
<td>39.9</td>
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<td>Ciudad Real</td>
<td>51,118 (3.1%)</td>
<td>484 (3.5)</td>
<td>3.7</td>
<td>96.3</td>
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<tr>
<td></td>
<td>Cuenca</td>
<td>41,791 (2.6%)</td>
<td>620 (5.3)</td>
<td>21.9</td>
<td>59.2</td>
<td>18.9</td>
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<tr>
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<td>Guadalajara</td>
<td>56,937 (3.5%)</td>
<td>2,493 (15.5)</td>
<td>27.4</td>
<td>71.0</td>
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<td>Illescas</td>
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<td>289 (16.1)</td>
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<td>43.3</td>
<td>3.5</td>
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<td>Puertollano</td>
<td>48,747 (3.0%)</td>
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<td>92.9</td>
<td>4.0</td>
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<td>Talav. Reina</td>
<td>64,136 (3.9%)</td>
<td>1,381 (8.0)</td>
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<td>37.2</td>
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<td>Toledo</td>
<td>57,769 (3.6%)</td>
<td>742 (4.6)</td>
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<td>68.6</td>
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<td>Valdepeñas</td>
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<td>116 (1.7)</td>
<td>3.4</td>
<td>84.5</td>
<td>12.1</td>
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</table>

#### Additional Notes

1. The three columns sum 100%
2. The value of this column is the sum of the columns (4) and (5)
3. Including Toledo
4. Excluding the FUA centres

**Types of relation:** (H) Hierarchical relationship (towards a greater centrality-level municipality); (T) First-order tangential relationship (between FUA centres); (t) Second-order tangential relationship (between non-FUA centres); (NH) Non-hierarchical relationship (towards a lower centrality-level municipality)

* It is important to bear in mind that the sample of each total is notoriously different: one set of municipalities is comprised only by the 11 FUA centres compared to the other one composed by 908 municipalities. Therefore, since the aggregated figures could lead to erroneous conclusions, the average for each municipality (in regards to its centrality is obtained) is obtained to allow comparisons.

** In comparison with other CLM municipalities inter-regional relationship and its own evolution over time, statistics for this municipality may be distorted.
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E.V. Excluded variable by the SPSS backward stepwise procedure
1 Standardized (or beta) coefficients indicate how many standard deviations the dependent variable change, per standard deviation increase in the predictor variable.
2 Population of the FUA centre from which the origins are originated for each temporal scenario.
3 The model for 2011 performs somewhat better than those for 2001 and 1981.
4 The R²-statistics suggest that the considered independent variables explain fairly well the variability of the out-commuting share between FUA centres. However, these figures indicate that other explanatory variables (such as individual characteristics) may be relevant in estimating commuting patterns (SANDOW and WESTIN, 2010).
5 The R²-statistics varying from 0.538 for the 1981 scenario, 0.871 for 2001 and 0.846 for 2011 suggest that the considered independent variables explain fairly well the variability of the FUA centres’ inter-regional out-commuting share (more so in the last two models). However, these figures indicate that other explanatory variables (such as socio-economic features of commuters, the urban systems established in these regions –e.g., less dynamic in the western adjacent Extremadura administrative region- or the presence of surrounding mountain ranges) may be relevant in estimating commuting patterns.

Table A.VII.2. – Regression models out-commuting flows by destination. Source: authors.
### APPENDIX VII – PAPER 2’s additional information

**Changing Commuting Patterns in Rural Metro-Adjacent Regions: the case of Castilla-La Mancha (Spain)**

<table>
<thead>
<tr>
<th>Total out-commuting evolution</th>
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<tr>
<td>B</td>
<td>Sig.</td>
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<tr>
<td>POP</td>
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<tr>
<td>POP VARIATION 81-11</td>
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<tr>
<td>FUA ACC VARIATION 81-11</td>
<td>E.V.</td>
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<tr>
<td>D MAD</td>
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<tr>
<td>D OTHER UA</td>
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<tr>
<td>Constant</td>
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<td>R² adjusted</td>
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<td>D OTHER UA</td>
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<tr>
<td>Constant</td>
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<td>R² adjusted</td>
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<td>D OTHER UA</td>
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<td>Constant</td>
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<td>R² adjusted</td>
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<tr>
<td>D MAD</td>
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<tr>
<td>D OTHER UA</td>
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<tr>
<td>Constant</td>
</tr>
<tr>
<td>R² adjusted</td>
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<table>
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<th>Out-comm. to other FUA centres evolution</th>
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<td>D OTHER UA</td>
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<td>R² adjusted</td>
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<th>Out-comm. to other regions evolution</th>
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<td>D OTHER UA</td>
</tr>
<tr>
<td>Constant</td>
</tr>
</tbody>
</table>

*Population of the FUA centre from which the origins are originated for each temporal scenario.*

Table A.VII.2. (Continued) – Regression models out-commuting flows variations by destination. *Source: authors.*
Table A.VII.3. – Number of municipalities regarding their prevailing functional relation and total share of out-commuting for each FUA or DA. Year 2001. Source: authors based on 2001 Census.

<table>
<thead>
<tr>
<th>Type</th>
<th>Name</th>
<th>% of FUA muni. with a prevailing relation to... (% of out-commuting towards...)</th>
<th>Madrid Region</th>
<th>CLM</th>
<th>Other region</th>
</tr>
</thead>
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<td>Functional Urban Area</td>
<td>Albacete</td>
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<td>92.4 (70.3)</td>
<td>7.6* (22.4)</td>
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<tr>
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<td>Toledo</td>
<td>19.4* (29.3)</td>
<td>80.6 (68.9)</td>
<td>0.0 (1.8)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Guadalajara</td>
<td>34.0** (48.9)</td>
<td>63.1 (49.0)</td>
<td>2.5 (2.1)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ciudad Real</td>
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<td>0.0 (5.5)</td>
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</tr>
<tr>
<td></td>
<td>Talavera de la Reina</td>
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<td>88.9 (64.4)</td>
<td>0.0 (6.8)</td>
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</tr>
<tr>
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<td>Alcázar-Tomellado</td>
<td>30.8** (44.8)</td>
<td>69.2 (47.0)</td>
<td>0.0 (8.2)</td>
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<tr>
<td></td>
<td>Cuenca</td>
<td>3.7 (14.8)</td>
<td>84.8 (63.7)</td>
<td>11.6* (25.6)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Illescas</td>
<td>50.0** (55.3***)</td>
<td>50.0 (44.0)</td>
<td>0.0 (0.7)</td>
<td></td>
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<td>33.3** (49.3***))</td>
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<tr>
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<td>Manzanares</td>
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<td>Almansa</td>
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<td>40.0** (61.7***)</td>
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<td></td>
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<td>Molina de Aragón</td>
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</tr>
</tbody>
</table>

* FUA/DA considerably linked with external locations (5-25% of the municipalities have a prevailing out-commuting either with Madrid or with other region). ** FUA/DA highly linked with external locations (>25% of the municipalities have a prevailing out-commuting either with Madrid or with other region). *** FUA/DA with a total share of out-commuting with other region (including Madrid) higher than that taking place within the regional boundaries.
RELACIONES FUNCIONALES DE PROFESIONALES ALTAMENTE CUALIFICADOS EN ÁREAS DISTANTES DE REGIONES URBANAS MULTICÉNTRICAS: EL CASO DE LOS INGENIEROS DE CAMINOS EN EL Contexto MADRILEÑO.

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Relaciones funcionales de profesionales altamente cualificados en áreas distantes de regiones urbanas multicéntricas: el caso de los Ingenieros de Caminos en el contexto madrileño (Resumen)

La evolución de los sistemas urbanos de unos modelos monocéntricos hacia otros más policéntricos y la emergencia de centralidades político-administrativas en áreas distantes pertenecientes a Regiones Metropolitanas Multicéntricas, así como la mejora de las infraestructuras de transporte son factores que han jugado un papel clave en la creciente complejidad de áreas metropolitanas, modificando no solo la red de ciudades sino sus relaciones funcionales, reorganizando los patrones de movilidad. El objetivo de este artículo es identificar los patrones de movilidad por motivos laborales de profesionales altamente cualificados residiendo en dichas áreas distantes y analizar hasta qué punto la metrópoli continuará polarizando un porcentaje significativo de los desplazamientos. Para ello se toma la Región Metropolitana madrileña y el sector de los Ingenieros de Caminos residentes en Castilla-La Mancha como caso de estudio. Los resultados empíricos muestran que, a pesar de que la metrópoli continúa ejerciendo una atracción crucial, nuevas centralidades (en particular, la capital regional) comienzan a concentrar un creciente número de ligazones funcionales, más significativo para los viajes de negocio realizados por dichos profesionales altamente cualificados que para los viajes por motivos de commuting realizados por el total de hogares regionales.

Palabras clave: commuting, viajes de negocios, profesionales altamente cualificados, regiones metropolitanas multicéntricas, capitales regionales.

The functional relationships of high-level professionals in distant areas of multicentric metropolitan regions: the case of Civil Engineers in the Madrilenian context (Abstract)

The process of evolution from monocentric to polycentric urban structures and the emerging politico-administrative centralities in distant areas of multicentric metropolitan regions, together with transport network improvements, are all factors which have played a key role in the growing complexity of metropolitan areas, modifying not only urban-settlement structures but also functional relationships and re-organizing mobility patterns. The aim of this paper is to identify the work-related mobility patterns of the highly-skilled professionals residing in those distant areas and to discuss the extent to which the traditional metropolitan core remains the major factor in mobility patterns. In order to do this, an analysis of the Madrid Metropolitan Region and Civil Engineers residing in Castilla-La Mancha was conducted. The empirical findings show that, although metropolises indeed exert a crucial attraction, new centralities, in particular the regional capital, start polarizing functional linkages, more significantly for highly-skilled professional business travel than for the average working-population commuting flows.

Keywords: commuting, business travel, highly-skilled professionals, multicentric metropolitan regions, regional capital cities.

Los fenómenos de dispersión y descentralización de la población y las actividades económicas en áreas metropolitanas, así como las mejoras de transporte han dado lugar a nuevos patrones de viaje, caracterizados por un aumento de las relaciones periferia-periferia y centro-periferia, mientras los flujos atraídos por el centro metropolitano se han reducido (Clark y Kuipers-Linde, 1994). Sin embargo, este aumento generalizado de las relaciones de commuting centrífugas no pueden ser generalizados al total de la población trabajadora (Aguirera et al., 2009).

La relevancia de la movilidad en los procesos urbanos queda de manifiesto en la amplia colección de estudios existentes al respecto. Sin embargo, una parte considerable de ellos se ha centrado fundamentalmente en la movilidad obligada (Cervero, 1996; Sick y Harder, 2008; Hincks y Wong, 2010) pasando la movilidad no obligada, es decir, por motivos de viaje no laborales a un segundo plano (Hall y Pain, 2006; Limtanakool et al., 2007a).

Los patrones de movilidad tanto por motivos laborales como no laborales en áreas distantes pertenecientes a Regiones Metropolitanas Multicéntricas han sido previamente analizados por Mohino et al. (2013), concluyendo que nuevas relaciones tangenciales comienzan a aparecer, de manera más notoria para viajes de negocios que para otros motivos de viaje. Sin embargo, diversas cuestiones quedan pendientes por conocer en estas áreas. Entre otros, cómo más allá del proceso de reorganización de los sistemas metropolitanos a través de un nuevo sistema de centralidades, determinados perfiles socio-económicos (profesionales altamente cualificados) representan un papel significativo en los patrones de movilidad en contraposición al resto de la población que sigue fundamentalmente atado al tradicional modelo centro-periferia.

El objetivo de este artículo es caracterizar los patrones de movilidad de profesionales altamente cualificados residiendo en áreas distantes de Regiones Metropolitanas Multicéntricas. En concreto, en áreas recientemente reorganizadas en regiones politico-administrativas, con nuevas capitales regionales que pueden concentrar un elevado número de servicios del sector público. El fin último es por tanto entender el impacto de estas emergentes centralidades regionales frente al papel polarizador ejercido por la tradicional metrópoli. Para ello, en primer lugar se comparan tanto los patrones de commuting como los desplazamientos por motivos de negocio de los profesionales altamente cualificados con los del total de la población (ocupada) regional. Asimismo, se contrastan para dicho sector profesional, ambos patrones de viaje (commuting y negocios) así como las relaciones que conllevan un desplazamiento y las virtuales.

Los análisis se realizan para la comunidad de Castilla La Mancha (en adelante CLM), como buen caso de estudio de área distante en la Región Metropolitana Multicéntrica de Madrid. Debido a la escasez de fuentes disponibles que, para profesionales altamente cualificados, recojan información no solo de los desplazamientos residencia-trabajo sino de otros motivos de viaje (como los de negocio), los análisis aquí presentados se centran en la información obtenida a través de una encuesta propia dirigida en un sector profesional concreto: los Ingenieros de Caminos. No obstante, a pesar de dicha limitación metodológica, el análisis muestra la existencia de cambios que reflejan transformaciones en el espacio social y funcional metropolitano, lo cual dibuja una indudable línea de investigación futura.
Nuevos patrones urbanos y de movilidad

La relación entre forma urbana (sistema de ciudades, densidad de población y empleo y usos del suelo) y patrones de movilidad es innegable pero a la vez compleja. Muestra de ello son los numerosos estudios centrados en entender las relaciones funcionales de un territorio a través de la movilidad, en concreto empleando fundamentalmente flujos laborales de commuting (Green, 1995; Cervero, 1996; Castañer et al., 2000; Sick and Harder, 2008; Feria and Albertos, 2010; Hincks and Wong, 2010) como el motivo de viaje diario más recurrente (Manaugh et al., 2010).

Un amplio porcentaje de estas investigaciones previas han analizado la dispersión urbana y el policentrico en qué medida estas nuevas estructuras urbanas han dado lugar a un cambio en las ligazones funcionales atendiendo a distancias y tiempos de viaje así como modos de transporte (Cervero y Wu, 1997; van der Laan, 1998; Titheridge y Hall, 2006; Solís et al, 2012) aunque sus conclusiones han sido contradictorias. Mientras que algunos de ellos concluyen que las emergentes regiones urbanas policéntricas disminuyen las distancias y los tiempos de commuting, de acuerdo con las hipótesis de la ‘co-location’ (Gordon et al., 1986; Giuliano y Small, 1993), otros concluyen totalmente lo contrario (Cervero y Wu, 1998). No obstante, los estudios más recientes tienden a concluir que la dispersión de la población y la descentralización de las actividades económicas dando lugar a estructuras urbanas policéntricas han contribuido al aumento de las distancias de commuting y a la dependencia del vehículo privado (García-Palomares, 2010).

Igualmente, las más recientes investigaciones sostienen la idea de que los patrones de movilidad no solo responden a las diferentes localizaciones residencia y trabajo sino además a la estructura de los hogares (Gislon y Gillespie, 1997) así como a las características socioeconómicas de la población y los trabajadores (Punpuing, 1993; Titheridge y Hall, 2006; van de Coevering y Schwaben, 2006; Albertos et al., 2007; Prashker, 2008; Kim et al., 2012). No obstante, mientras un importante número de ellos se centra en las diferencias de movilidad por motivos de género (Fanning-Madden, 1981; White, 1986; Gordon et al, 1989; Blumen, 1994), tan solo unos pocos abordan su análisis desde el punto de vista del nivel profesional, los ingresos o la ocupación de la población desplazada (Jara-Diaz y Videl, 1989; Harsman y Quigley, 1998).

En términos generales, las investigaciones que contemplan variables socio-económicas se han centrado en su efecto en las distancias de commuting, concluyendo que la distancia/proximidad (entre residencia y trabajo) se hace menos relevante a medida que aumentan los salarios, el nivel de estudios o el número de vehículos en propiedad (Prashker et al., 2008; Dargy y Clark, 2012) tanto para motivos de viaje laborales como no laborales. Algunos de ellos justifican esta mayor movilidad (descrita en estudios más largos y más numerosos) de los profesionales de mayores ingresos y altamente cualificados a unas mayores áreas de búsqueda desde el lugar de residencia (García-Palomares, 2008). No obstante, existen igualmente diferencias según el género para personas de la misma edad, nivel de estudios, ingresos, status familiar, ocupación o estructura del hogar (Sandow, 2008), aunque según han concluido algunas investigaciones, las diferencias en los patrones de movilidad debido a las diferencias de género disminuyen a medida que aumenta el nivel educativo (Casado, 2000). Sin embargo, se encuentran igualmente conclusiones contradictorias entre la literatura existente, cuyos análisis muestran que no existe relación entre nivel de ingresos o estudios y el comportamiento de viaje (Antipova et al., 2001).

A pesar de que los desplazamientos residencia-trabajo han sido el principal objeto de estudio de investigaciones previas, debido a que otros motivos de viaje han supuesto un impacto importante en el incremento de los desplazamientos diarios durante las últimas décadas (Ureña y Muruzábal, 2006), estos han comenzado a incluirse en las investigaciones más recientes, como es el caso de los desplazamientos por motivos de ocio o compras (Schwanen et al., 2001; Alcántara de Vasconcellos, 2005; Hall y Pain, 2006; Limtanakool et al., 2009) o negocios[1] (Lamtanakool et al., 2007 y a; Aguilera et al, 2009).

Aunque de menor importancia que los desplazamientos por motivos de commuting, los viajes de negocios constituyen una componente esencial en días laborales (Ribeiro et al., 2010; Lyons, InPres) y comienzan a representar un porcentaje importante de la movilidad (Mason, 2002; Beaverstock et al., 2009). Su distribución varía dependiendo del tamaño de la compañía, del sector donde ésta desarrolla su actividad y de su estructura interna así como del género de los trabajadores, su posición en la empresa y su salario (Aguilera, 2008).

Los viajes de negocio internacionales tradicionalmente considerados como un importante proceso laboral, facilitando las relaciones empresariales a través de encuentros personales (cara-a-cara) (Faulconbridge et al., 2009; Haynes, 2010). La globalización, el incremento del número de multinacionales con sede en distintas localizaciones geográficas (cada vez más distantes entre sí) y las mejoras de las infraestructuras de transporte han dado lugar a un aumento considerable de este tipo de viajes (Faulconbridge et al., 2009; Instituto de Estudios Turísticos, 2001 and 2011), a pesar de la notoria proliferación en los últimos años del uso de tecnologías de la información y la comunicación (TICs), las cuales podrían considerarse sustitutos a los desplazamientos físicos (Alexander y Dijst, 2012; Julsrud et al., 2012). Una de las consecuencias de este rápido desarrollo de las TICs ha sido la generación de formas de trabajo más flexibles, permitiendo una mayor diversificación de los lugares de trabajo y la diferenciación entre la geografía del trabajo (donde se realiza) y la geografía del empleo y la localización de las empresas (Alexander y Dijst, 2012; Hermelin y Trygg, 2012). No obstante, frente a la esperada “death of distance” y consiguiente sustitución de los desplazamientos por las TICs, las actuales relaciones de negocios se caracterizan por una combinación de contactos físicos y virtuales dando lugar a una compresión espacio-tiempo pero donde los encuentros cara-a-cara continúan siendo importantes como la manera más efectiva de mantener relaciones de negocios (Saffo, 1993; Niles, 1994; Gaspar y Glaeser, 1998; Urry, 2003; Denstadli, 2004; Kakihara y Sorensen, 2004; Aguilera, 2008; Faulconbridge and Beaverstock, 2008; Faulconbridge et al., 2009; Haynes, 2010; Tillema et al., 2010; Denstadli et al., 2012; Hermelin y Trygg, 2012; Lyons, In Press). La elección de uno frente a otro tipo de contacto depende del sector y de la estructura geográfica de cada compañía (Denstadli et al., 2012), la distancia que necesita ser cubierta con el desplazamiento (Aguilera, 2008), las características del encuentro (tareas a realizar, contenido de las mismas, urgencia del encuentro, etc.) (Tillema et al., 2010) o la capacitación/familiaridad del trabajador con las TICs (Aguilera, 2008).

No obstante, aunque numerosos estudios han identificado una relación directa entre ingresos, nivel de estudios y otras variables socio-económicas y movilidad, la presente investigación considera igualmente los diferentes patrones de movilidad de profesionales altamente cualificados en comparación con el resto de población ocupada. Sin embargo, difiere de los anteriores estudios tanto en la escala del análisis, comparando commuting versus flujos de negocios en áreas distantes de regiones metropolitanas multicéntricas, como en la aproximación, diferenciando entre el papel atractor/polarizador de la metrópolis frente al de las emergentes centralidades de dichos territorios alejados (Ciudades Histórico-Administrativas y en especial Capitales Regionales). Es decir, el artículo debate hasta qué punto el tradicional centro metropolitano continúa liderando los patrones de movilidad en territorios distantes de regiones metropolitanas o si por el contrario nuevos flujos comienzan a emergir entre las capitales provinciales y la nueva capital regional (y en qué medida esto último ocurre de manera más significativa para uno u otro tipo de desplazamiento laboral –commuting vs. negocios- y para un determinado nivel educativo).

Área de estudio y aproximación metodológica

La Región Metropolitana Multicéntrica madrileña y la adyacente comunidad autónoma de Castilla-La Mancha como caso de estudio.

Los patrones de viaje laborales y las nuevas jerarquías urbanas regionales de áreas distantes integradas en procesos metropolitanos serán analizados a través de la región de CLM, como buen ejemplo de territorio alejado de la Región Metropolitana Multicéntrica madrileña (Solís et al., 2012).

Consolidado durante los años 50 y 60 del s. XX como un modelo metropolitano monocéntrico, caracterizado por un potente centro principal y una periferia adyacente altamente dependiente de él, desde los años 1980, en paralelo con los procesos de transporte y la descentralización de actividades, nuevas centralidades económicas han emergido dando lugar a una profunda transformación de la tradicional estructura urbana monocéntrica, que ha comenzado a evolucionar hacia otra policéntrica (Gallo et al., 2010) y sus procesos metropolitanos a desbordar sus límites administrativos hacia las provincias limítrofes de Castilla La Mancha y Castilla y León.

Consolidada en 1982 como región político-administrativa con Toledo como capital regional, CLM ha sido tradicionalmente considerada como un territorio desorganizado, sin cohesión funcional y acéfalo (Pillet et al., 2010), notablemente influido por Madrid[2] debido a la ausencia de un verdadero centro organizador.
La estructura urbana de CLM es funcionalmente dependiente de Madrid y sus interrelaciones económicas con el exterior han dominado sobre las internas en la región (Panadero et al., 1996). Solo el 4% de sus municipios (39 de 919) tenían más de 10.000 habitantes en 2012: solo uno de ellos (Albacete) una población superior a 100.000 hab., seis (Ciudad Real, Cuenca, Guadalajara, Puertollano, Talavera de la Reina y Toledo) entre 50.000 y 100.000 hab., ocho entre 20.000 y 50.000 hab. y veinticuatro entre 10.000 y 20.000 (Figura 1 y Cuadro 1).

Cuadro 1.
Evolución de la población de las provincias y capitales de Castilla La Mancha (1981-2012)

<table>
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<td></td>
<td>(Hab.) (%)</td>
<td>(Hab.) (%)</td>
<td>(Hab.) (%)</td>
</tr>
<tr>
<td>Albacete (Capital)</td>
<td>111.716 (35)</td>
<td>149.507 (41)</td>
<td>172.472 (43)</td>
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<tr>
<td>Otros municipios &gt; 20.000 hab.</td>
<td>42.982 (13)</td>
<td>74.327 (20)</td>
<td>83.219 (21)</td>
</tr>
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<td>Resto de la provincia de Albacete</td>
<td>174.360 (52)</td>
<td>214.449 (39)</td>
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<td>Total Provincia Albacete</td>
<td>334.488 (100)</td>
<td>367.283 (100)</td>
<td>361.004 (100)</td>
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<td>Ciudad Real (Capital)</td>
<td>51.118 (11)</td>
<td>61.280 (13)</td>
<td>74.921 (14)</td>
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<td>Otros municipios &gt; 30.000 hab.</td>
<td>215.337 (41)</td>
<td>234.321 (28)</td>
<td>254.294 (29)</td>
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<td>Resto de la provincia de Ciudad Real</td>
<td>291.076 (62)</td>
<td>284.959 (60)</td>
<td>301.035 (57)</td>
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<td>Total Provincia Ciudad Real</td>
<td>468.327 (100)</td>
<td>478.581 (100)</td>
<td>501.507 (100)</td>
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<td>Cuenca (Capital)</td>
<td>41.791 (100)</td>
<td>46.491 (23)</td>
<td>52.032 (26)</td>
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<td>Resto de la provincia de Cuenca</td>
<td>167.207 (80)</td>
<td>155.035 (77)</td>
<td>161.004 (74)</td>
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<td>Total Provincia Cuenca</td>
<td>208.998 (100)</td>
<td>201.526 (100)</td>
<td>213.036 (100)</td>
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<td>Guadalajara (Capital)</td>
<td>56.922 (14)</td>
<td>67.640 (39)</td>
<td>84.803 (33)</td>
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<td>20.383 (12)</td>
<td>35.146 (14)</td>
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<tr>
<td>Resto de la provincia de Guadalajara</td>
<td>48.097 (46)</td>
<td>83.509 (49)</td>
<td>139.588 (54)</td>
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<tr>
<td>Total Provincia Guadalajara</td>
<td>105.019 (100)</td>
<td>112.532 (100)</td>
<td>265.532 (100)</td>
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<td>Toledo (Capital)</td>
<td>57.769 (12)</td>
<td>69.450 (13)</td>
<td>84.019 (12)</td>
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<td>64.136 (14)</td>
<td>76.011 (14)</td>
<td>113.336 (16)</td>
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<td>Resto de la provincia de Toledo</td>
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<td>390.676 (73)</td>
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<td>417.806 (100)</td>
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<td>Total Región Castilla La Mancha</td>
<td>1.588.618 (100)</td>
<td>1.755.053 (100)</td>
<td>2.212.888 (100)</td>
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</table>
Fuente: INE.

El carácter de paso del sistema de transporte de CLM ha sido un condicionante clave en la dinámica urbana regional y a pesar de las mejoras de transporte de las últimas décadas, que han comenzado a transformar la tradicional red de ferrocarril y carreteras, predominantemente radial, en otra radioconcentrada en torno a la metrópoli aunque en el territorio castellanomanchego las infraestructuras continúan siendo proyectadas bajo lógicas nacionales conectando Madrid con otras grandes áreas metropolitanas más alejadas. En cuanto a la red de carreteras, los principales cambios que han tenido lugar en el área de estudio han sido principalmente tres: a) la adecuación (o duplicación) de las carreteras nacionales a los estándares de autovía en todo el área de estudio, reduciendo considerablemente los tiempos de viaje (ver Cuadro 2); b) la construcción de cuatro nuevas autovías orbitales/semi-orbitales en la provincia/región madrileña (M-30, M-40, M-45 and M-50); c) construcción de tres tramos de autovía tangenciales (CM-42, A-43 and A-40) en CLM[3]. En cuanto a la red ferroviaria, los cambios han consistido en la reducción del número de servicios de la red convencional, la ampliación del ferrocarril suburban/cercanías más allá de los límites de la región madrileña y la creación de la red de Alta Velocidad entre cada una de las provincias de CLM y Madrid[4].

Cuadro 2.
Evolución de los tiempos de viaje por carretera entre las principales ciudades de
La mayor parte de los estudios de movilidad en la Región Centro española han limitado sus análisis a territorios cercanos a la metrópoli, aproximadamente a unos 50 km en torno a ella (Gallo et al., 2010; García-Palomares, 2010; Gutiérrez-Puebla and Garcia-Palomares, 2007) y tan solo una minoría considera áreas más alejadas (Pillet et al., 2010; Solís et al., 2012). Por otro lado, debido a la falta de datos de movilidad actualizados/recientes, principalmente se han limitado a analizar la evolución de ligazones laborales para un periodo de veinte años (1981-2001), y sólo unos pocos estudios consideran otros motivos de viaje. Por ello, el presente artículo pretende ir más allá, tratando de comparar las diferencias en los patrones de movilidad del total de la población regional y de un sector de profesionales altamente cualificados (los ingenieros de caminos), analizando no solo de los viajes de commuting sino de un tipo de viaje que comienza a cobrar especial importancia en los desplazamientos diarios, los viajes de negocio, y cubriendo un territorio más distante del hasta ahora considerado en este tipo de estudios.

### Fuentes de información y metodología

El interés de centrarnos en los viajes de negocio y su comparativa con los desplazamientos laborales más recurrentes tiene una justificación doble. En primer lugar, movimientos laborales (comuting) y viajes de negocio son el resultado de la actividad económica de la ciudad y su dinámica, por lo que mantienen una estrecha vinculación con el ciclismo de la población y la respuesta laboral. En segundo lugar, la movilidad laboral, tanto para el movimiento de personas como para el transporte de mercancías, ha sido uno de los aspectos que han experimentado el mayor desarrollo en los últimos años, tanto por el impacto que ha tenido la globalización en el comercio y las inversiones de capitales, como por el desarrollo de nuevos sistemas de transporte que han facilitado la movilidad laboral.

En este contexto, el más significativo de los desplazamientos laborales es el commuting, definido como el desplazamiento diario entre la residencia y el lugar de trabajo. En este sentido, la metodología empleada consistió en dirigir un cuestionario a residentes de la Región Centro, con el objetivo de recoger información sobre su actividad laboral y desplazamientos diarios. El cuestionario se elabora en torno a dos bloques: uno primero más general, destinado a obtener información básica del profesor encuestado (sexo, edad, ciudad donde cursó sus estudios y año de finalización, municipio de residencia, municipio de trabajo, etc.). El segundo centrado en las relaciones profesionales: a) viajes laborales frecuentes (diferentes a los residencia-trabajo) y sus frecuencias, b) viajes laborales realizados durante la última semana laboral (completa) anterior a la realización de la encuesta (destino, modo de transporte y frecuencia con la que realiza ese tipo de desplazamiento) y c) número de contactos profesionales (vía teléfono, correo postal, correo electrónico, etc) sin desplazamiento realizados durante el último día laboral anterior a la encuesta. El tercer y último bloque pretendía caracterizar la compañía donde el profesional trabaja (principales actividades, tamaño, etc.).

Con toda esta información, la articulación territorial del área distante de la Región Metropolitana Multicéntrica madrileña se analizará desde una doble

<table>
<thead>
<tr>
<th>Ciudad Real</th>
<th>Cuenca</th>
<th>Guadalajara</th>
<th>Madrid</th>
<th>Toledo</th>
</tr>
</thead>
<tbody>
<tr>
<td>134</td>
<td>10</td>
<td>112</td>
<td>25</td>
<td>192</td>
</tr>
<tr>
<td>145</td>
<td>31</td>
<td>159</td>
<td>16</td>
<td>132</td>
</tr>
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<td>83</td>
<td>0</td>
<td>99</td>
<td>22</td>
<td>117</td>
</tr>
<tr>
<td>34</td>
<td>27</td>
<td>3</td>
<td>26</td>
<td>Guadalajara</td>
</tr>
<tr>
<td>47</td>
<td>23</td>
<td>Madrid</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fuente: elaboración propia.
aproximación. En primer lugar, a través de una comparativa entre los patrones de movilidad del total de la población regional y de los ICCPs en términos de desplazamientos de commuting y negocios. En segundo lugar, a través de la comparativa entre viajes de negocio (y contactos cara-a-cara) y contactos virtuales.

Con el fin de caracterizar la capacidad de polarización de las principales centralidades de Regiones Metropolitanas Multicéntricas, en estos análisis se discretizarán las relaciones funcionales en función del tipo de destino, distinguiendo entre:

a) Relaciones intraprovinciales jerárquicas: desplazamientos intermunicipales con destino la capital de la provincia de residencia.

b) Relaciones intraprovinciales no jerárquicas: desplazamientos intermunicipales con destino otro municipio de la provincia de residencia (excluyendo la capital).

c) Relaciones intraprovinciales totales, como suma de los dos tipos de flujo anteriores, es decir, desplazamientos intermunicipales con destino otro municipio de la provincia de residencia.

d) Relaciones tangenciales jerárquicas: desplazamientos intermunicipales con destino la capital regional (en el caso del área de estudio, Toledo).

e) Relaciones tangenciales no jerárquicas: desplazamientos intermunicipales con destino otras provincias castellanomanchegas (excepto al municipio de Toledo).

f) Relaciones tangenciales totales, como suma de los dos tipos de flujo anteriores, es decir, desplazamientos intermunicipales con destino otro municipio regional (de una provincia diferente a la de residencia).

g) Relaciones radiales jerárquicas: desplazamientos intermunicipales con destino el municipio de Madrid

h) Relaciones radiales no jerárquicas: desplazamientos intermunicipales con destino con otros municipios madrileños (excluyendo Madrid)

i) Relaciones radiales totales, como suma de los dos tipos de flujo anteriores, es decir, desplazamientos intermunicipales con destino otro municipio de la provincia madrileña

j) Relaciones inter-regionales: desplazamientos intermunicipales hacia otras regiones españolas, excepto la madrileña

k) Relaciones internacionales: desplazamientos intermunicipales hacia otros países

Resultados empíricos

Uno de los primeros resultados que puede extraerse de la investigación es que los ICCP tienden a residir más en municipios con altos niveles de centralidad que el total de la población regional. Así, frente al 22% de la población regional (INE, 2012), en torno al 70% de los ICCPs (Encuesta Propia, 2012) reside en las capitales provinciales. Por otro lado, asumiendo que los ICCPs se comportan de manera similar a los graduados universitarios en CLM, todos los flujos de commuting dirigidos hacia municipios de altos niveles de centralidad (capital provincial, regional o nacional) han aumentado entre 2001 y 2012, mientras que las únicas relaciones laborales que con destino otros municipios, han aumentado son las tangenciales e interregionales (ver Cuadro 3).

Patrones de commuting de los hogares regionales versus ICCPs

De acuerdo con las encuestas realizadas por los autores en 2012, la principal diferencia es que un mayor porcentaje de ICCPs (42,4%) que el del total de la población castellanomanchega (28,1% de los cabezas de familia)[6] lleva a cabo desplazamientos intermunicipales por motivos de commuting. Si Mohino et al. (2013) concluyen que los territorios distantes de regiones metropolitanas multicéntricas han experimentado durante los últimos años un aumento de movilidad superior al de la media nacional, los datos aquí presentados muestran que los profesionales altamente cualificados presentan incluso una mayor movilidad en estas áreas distantes.

Igualmente, los patrones (distribución según destino de viaje) de desplazamientos intermunicipales también son diferentes (ver Cuadro 3). En ambos casos las relaciones de commuting intraprovinciales representan en torno a la mitad de los flujos intermunicipales, pero además de que la mitad de los ICCPs residen en las capitales provinciales, el 50% de sus desplazamientos de commuting intraprovinciales tiene lugar hacia ellas, mientras que los hogares regionales (teniendo en cuenta tanto el cabeza de familia como todos los miembros ocupados) se desplazan entre tres y cuatro veces más hacia otros municipios intraprovinciales diferentes a la capital. Por tanto, en estas áreas distantes, un alto porcentaje de ICCPs viven en y se desplazan por motivos de trabajo hacia municipios de alta centralidad (capitales de provincia).

En relación a las interacciones radiales y tangenciales en 2012, las diferencias son aún más significativas. En primer lugar, en ambos casos, el total de relaciones tangenciales son menores que las radiales, aunque la diferencia entre ellas es menor para los ICCPs (50% menores) que para el total de hogares regionales (en torno a siete veces menor). Esto muestra que los ICCP son menos dependientes del área metropolitana y sus patrones más multicéntricos. En segundo lugar, las relaciones radiales para los ICCPs tienen lugar únicamente con Madrid, mientras que un tercio de las ligazones radiales de los hogares tiene lugar hacia otros municipios madrileños. Esto sostiene y refuerza la hipótesis de que los profesionales altamente cualificados se relacionan con otros lugares de alto nivel jerárquico. En tercer lugar, las relaciones tangenciales con Toledo representan una componente pequeña del total de flujos tangenciales, pero mientras que son mínimas para los hogares regionales, representan cerca del 4% de los flujos intermunicipales de los ICCPs, reforzando las características multicéntricas de los patrones de commuting de estos profesionales y la creciente importancia de la capital regional para ellos.

Cuadro 3.

Evolución de los patrones de commuting de los hogares regionales frente a los de los ICCP según el destino del desplazamiento (2001-2012)

<table>
<thead>
<tr>
<th>Tipo de relación</th>
<th>2012 basado en la encuesta propia</th>
<th>2001 basado en la información del Censo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Hogares</td>
<td>ICCPs</td>
</tr>
<tr>
<td>Jerárquicas con la capital de provincia</td>
<td>8,6</td>
<td>26,4</td>
</tr>
<tr>
<td>Intraprov. con otro municipio de la prov. de residencia</td>
<td>41,2</td>
<td>24,5</td>
</tr>
<tr>
<td>Intraprovincial (total)</td>
<td>49,8</td>
<td>50,9</td>
</tr>
<tr>
<td>Tangencial (con Toledo)</td>
<td>0,2</td>
<td>3,6</td>
</tr>
<tr>
<td>Tangencial (con otro municipio de CLM)</td>
<td>4,6</td>
<td>11,3</td>
</tr>
<tr>
<td>Tangencial (total: con otra provincia de CLM)</td>
<td>4,8</td>
<td>15,1</td>
</tr>
<tr>
<td>Radial (con Madrid)</td>
<td>28,5</td>
<td>24,5</td>
</tr>
<tr>
<td>Radial (con otro municipio madrileño)</td>
<td>11,7</td>
<td>9,0</td>
</tr>
<tr>
<td>Radial (total)</td>
<td>40,1</td>
<td>24,5</td>
</tr>
<tr>
<td>Inter-regional (con otras regiones españolas)</td>
<td>5,2</td>
<td>9,4</td>
</tr>
</tbody>
</table>
Por último, en 2012 los patrones de commuting hacia otras regiones españolas son algo más frecuentes para los ICCP (aunque de menor intensidad que las relaciones tangenciales).

Patrones de viajes por motivos de negocio de los hogares regionales versus ICCPs

Los desplazamientos de negocio igualmente difieren al comparar la población regional con los ICCPs de acuerdo a las encuestas propias (ver Cuadro 4). Aunque en ambos casos las relaciones intraprovinciales muestran un peso importante en el total de flujos intermunicipales, su intensidad es superior en el caso de los hogares regionales (40.9% frente al 33.7%), lo que muestra cómo los ICCPs se relacionan con un territorio más alejado por motivos de negocio. Por otro lado, este tipo de flujos son más jerárquicos (dirigidos hacia la capital de provincia) para el total de la población regional que para los ICCPs. Esto podría deberse a que estos profesionales ya residen y/o trabajan en ellas, no siendo necesario realizar un viaje intermunicipal para acceder a ellas.

Otra de las diferencias se encuentra a la hora de comparar relaciones radiales y tangenciales, siendo las primeras más significativas que las segundas tanto para los hogares como para los ICCPs. No obstante, para el sector de profesionales considerado, la diferencia es menos importante que para el total de la población regional (ver Cuadro 4). Es decir, las relaciones de negocio de los hogares regionales son más dependientes del tradicional área metropolitana mientras que las de los ICCPs se encuentran más diversificadas.

<table>
<thead>
<tr>
<th>Tipo de relación por motivos de negocio</th>
<th>Cabeza de Familia</th>
<th>ICCPs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jerárquicas con la capital de provincia</td>
<td>15,0</td>
<td>5,9</td>
</tr>
<tr>
<td>Intraprovincial con otro municipio de la prov. de residencia</td>
<td>25,9</td>
<td>27,7</td>
</tr>
<tr>
<td>Intraprovincial (total)</td>
<td>40,9</td>
<td>33,7</td>
</tr>
<tr>
<td>Tangencial (con Toledo)</td>
<td>3,8</td>
<td>6,9</td>
</tr>
<tr>
<td>Tangencial (con otro municipio de CLM)</td>
<td>11,2</td>
<td>15,9</td>
</tr>
<tr>
<td>Tangencial (total: con otra provincia de CLM)</td>
<td>14,9</td>
<td>20,8</td>
</tr>
<tr>
<td>Radial (con Madrid)</td>
<td>21,3</td>
<td>24,8</td>
</tr>
<tr>
<td>Radial (con otro municipio madrileño)</td>
<td>3,1</td>
<td>3,8</td>
</tr>
<tr>
<td>Radial (total)</td>
<td>24,5</td>
<td>27,7</td>
</tr>
<tr>
<td>Inter-regional (con otras regiones españolas)</td>
<td>19,3</td>
<td>15,8</td>
</tr>
<tr>
<td>Internacional (con otros países)</td>
<td>0,4</td>
<td>2,6</td>
</tr>
</tbody>
</table>

En ambos casos la capacidad centralizadora y de polarización de Toledo es menor que la de Madrid. Sin embargo, para los ICCPs, la importancia de la capital regional como destino por motivos de negocio es prácticamente el doble de la que supone para el total de hogares, mientras que Madrid tan solo atrae ligeramente un número de desplazamientos superior en el caso de los ICCPs. Esto significaría una más notable centralidad de Toledo por motivos de negocio para el caso de los profesionales altamente cualificados que para el total de la población regional y que vendría influido por un mayor número de puestos de empleo de alto nivel profesional disponibles en la capital regional.

Por último, comparando la capacidad de atracción de la región de Madrid con el resto de regiones, la primera atrae un mayor número de desplazamientos en ambos casos aunque la diferencia es más significativa para el caso de los ICCPs, lo que podría ser debido a que en este caso, los puestos de trabajo están altamente ligados al sector público, muy presente en la capital nacional. En cuanto a las relaciones de negocio internacionales, en ambos casos son limitadas, aunque prácticamente inexistentes para el total de la población regional (cinco veces menor que para los ICCPs).

Patrones de desplazamientos de commuting versus desplazamientos por motivos de negocios

Mohino et al. (2013) al analizar la movilidad de los hogares regionales en 2012 llegan fundamentalmente a tres conclusiones. En primer lugar, que los patrones de commuting son más complejos que los de negocios, los cuales están más centralizados en un menor número de destinos de alta centralidad (principalmente Madrid y las capitales provinciales). En segundo lugar, que los flujos de negocios tangenciales (tanto hacia Toledo como a otros territorios regionales) son claramente superiores que los tangenciales por motivos de commuting. Finalmente, que los viajes de negocios cubren distancias mayores que los de residencia-trabajo.

A diferencia de estos patrones de movilidad de los hogares regionales, la estructura de los desplazamientos por motivo de negocio de los ICCPs es más compleja que la de commuting (ver Figura 2)
Aunque las relaciones interprovinciales son las más significativas en los desplazamientos intermunicipales de los ICCPs tanto por motivos de commuting como de negocios, el número de flujos de negocios dentro de la misma provincia de residencia es inferior al que tiene lugar por desplazamientos residencia-trabajo y la capital provincial ejerce un menor papel polarizador en los viajes de negocio que de commuting. Esta aparente contradicción de una menor atracción provincial junto a una menor influencia de las capitales provinciales como principal destino de viajes de negocios podría ser debido a que, como ya se ha mencionado anteriormente, un alto porcentaje de ICCPs residen en ellas y por tanto no son necesarios desplazamientos intermunicipales para acceder a las oportunidades de negocio.

Por otro lado, para el caso de los ICCPs, las relaciones radiales y tangenciales representan un notable componente tanto para los viajes de commuting como de negocio. Sin embargo, mientras que la capacidad de Madrid en la atracción de ICCPs es similar para ambos motivos de viaje (en torno a un 24%), la polarización de Toledo de viajes de negocio casi duplica la de los desplazamientos residencia-trabajo. Esto, una vez más, sostiene y refuerza la hipótesis de que las relaciones de negocios de profesionales altamente cualificados hacia las nuevas capitales provinciales parecen estar desarrollándose en mayor medida que las de commuting.

Considerando que el municipio de Madrid representa casi el 40% y Toledo solo el 1% del total de la población de ambas regiones (CLM y Madrid), proporcionalmente a su población, la capacidad de atracción del municipio de Toledo es superior a la de Madrid para el caso de los ICCPs. Así, Toledo atrae casi cuatro (3.8) y siete (6.9) veces más relaciones de commuting y negocios que el porcentaje que representa su población, mientras que Madrid reduce ambas aproximadamente vez y media (1.6) en relación a su población (ver Cuadro 5). Esto es incluso más significativo al comparar estas cifras con la del total de la población ocupada en CLM, donde Toledo atrae casi el mismo porcentaje de desplazamientos de commuting (0.9%) que su población representa sobre el total de habitantes residentes en el área de estudio (ver Cuadro 3).

### Cuadro 5. Patrones de commuting y negocio de los ICCPs residentes en Castilla La Mancha

<table>
<thead>
<tr>
<th>Tipo de relación</th>
<th>% de viajes de commuting</th>
<th>% de viajes de negocio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Periféricas con la capital de provincia</td>
<td>26,6</td>
<td>5,9</td>
</tr>
<tr>
<td>Intraprov. con otro municipio de la prov. de residencia</td>
<td>24,5</td>
<td>27,7</td>
</tr>
<tr>
<td>Intraprovincial (total)</td>
<td>50,0</td>
<td>33,7</td>
</tr>
<tr>
<td>Tangencial (con Toledo)</td>
<td>3,8</td>
<td>6,9</td>
</tr>
<tr>
<td>Tangencial (con otro municipio de CLM)</td>
<td>11,3</td>
<td>13,9</td>
</tr>
<tr>
<td>Tangencial (total: con otra provincia de CLM)</td>
<td>15,1</td>
<td>20,8</td>
</tr>
<tr>
<td>Radial (con Madrid)</td>
<td>24,5</td>
<td>24,8</td>
</tr>
<tr>
<td>Radial (con otro municipio madrileno)</td>
<td>9,0</td>
<td>11,0</td>
</tr>
<tr>
<td>Radial (total)</td>
<td>24,5</td>
<td>27,7</td>
</tr>
<tr>
<td>Inter-regional (con otras regiones españolas)</td>
<td>9,4</td>
<td>15,8</td>
</tr>
<tr>
<td>Internacional (con otros países)</td>
<td>0</td>
<td>2,9</td>
</tr>
</tbody>
</table>

Fuente: Elaboración propia.

De acuerdo con las encuestas realizadas (y de manera similar a lo que han venido apuntando otros estudios como Limtanakool et al., 2006), puede concluirse que solo el 14% de los desplazamientos residencia-trabajo y el 23.3% de los de negocio no se realizan en vehículo privado y la Alta Velocidad Ferroviaria (AVF) es tan solo usada por los ICCPs para relaciones radiales con Madrid. Este notable número de relaciones radiales realizado en AVF supone aproximadamente un 10% de los flujos intermunicipales por motivos de commuting de los ICCPs y un 7% de los de negocio (ver Cuadro 6).

### Cuadro 6. Uso de los diferentes modos de transporte en función del motivo de viaje para los ICCPs residentes en Castilla La Mancha

<table>
<thead>
<tr>
<th>Modo de transporte</th>
<th>Commuting (%)</th>
<th>Negocios (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vehículo privado (usado principalmente en las relaciones radiales)</td>
<td>86,3</td>
<td>71,2</td>
</tr>
<tr>
<td>Bus o tren convencional (usados solo en relaciones radiales)</td>
<td>0,0</td>
<td>1,9</td>
</tr>
<tr>
<td>Tren de Alta Velocidad (usado exclusivamente en las relaciones con Madrid)</td>
<td>9,8</td>
<td>6,7</td>
</tr>
<tr>
<td>Avión (usado exclusivamente para relaciones internacionales)</td>
<td>0,0</td>
<td>1,9</td>
</tr>
<tr>
<td>Otros/varios modos de transporte</td>
<td>3,9</td>
<td>19,2</td>
</tr>
</tbody>
</table>

Fuente: Elaboración propia.

### Relaciones de negocio dentro y fuera de la misma empresa para profesionales altamente cualificados

Las relaciones de negocio de los ICCPs tienen lugar tanto entre sedes de la misma compañía como entre diferentes empresas y aunque ambas tienen un peso similar (según las encuestas recibidas, el 48% de las relaciones tienen lugar dentro de la misma empresa y el 52% entre empresas diferentes), sus patrones de viaje siguen tendencias diferentes en cada caso.

Las relaciones de negocios que dichos profesionales tienen dentro de su misma empresa tienen pesos similares para los diferentes tipos de relaciones (en torno a un 23%), excepto para el caso de relaciones radiales, cuya importancia es superior (31,8%), y de las relaciones internacionales, que no tienen lugar (ver Cuadro 7). Por el contrario, un porcentaje significativo de las relaciones de negocio que tienen lugar con otras empresas diferentes tiene lugar dentro de la misma provincia de residencia (42,1%), claramente superior a las que se realizan con la provincia de Madrid o el resto del territorio regional así como a las inter-regionales (cuya importancia es claramente inferior). Todo esto vendría a significar la relevancia de las relaciones verticales (con las sedes centrales localizadas en Madrid) en empresas del sector de la ingeniería civil y la fuerte colaboración con otras empresas a nivel local.

Asimismo, se concluye que la capacidad polarizadora de Madrid para relaciones de negocio tanto dentro de la misma empresa como con otras empresas diferentes superan entre tres y cuatro veces las ejercidas por Toledo (siendo estas diferencias superiores para el caso de las relaciones dentro de la misma compañía). Esto vendría a reforzar igualmente la conclusión anterior: importancia de relaciones verticales en empresas del sector ingenieril.

Por último, mientras que la relevancia de Madrid es, tanto para relaciones dentro de la misma empresa como con otras empresas, en torno a diez veces superior que la del resto de municipios madrileños, Toledo solo atrae la mitad del total de relaciones tangenciales (ver Cuadro 7). Esto demuestra por tanto la todavía notable
Relaciones de negocio con desplazamiento y virtuales para profesionales altamente cualificados

Comparando las relaciones intermunicipales cara-a-cara (aquellas que conllevan un desplazamiento) y las virtuales (teléfono, email, etc.) de los ICCPs por motivos de negocio, en términos relativos (porcentaje respecto al total de contactos llevados a cabo), las diferencias no son sustanciales entre uno y otro tipo (ver Cuadro 8). Esta conclusión coincide con Dupuy (2002, 2003), quien afirma que los contactos virtuales refuerzan sustancialmente las relaciones pre-existentes y las que tienen lugar entre distancias pequeñas, y no solo las nuevas o de larga distancia. No obstante, se pueden apreciar diferencias importantes para largas distancias. Así, aunque en los flujos con otras regiones españolas las relaciones con desplazamiento superan a las virtuales, la situación es completamente contraria para el caso de las relaciones internacionales. Por otro lado, el número total de contactos con desplazamiento es mucho menor (de media, 0,9 viajes por día el ICCP) que los virtuales (de media, 14,2 contactos por día e ICCP).

Además, de las encuestas se concluye que, al igual que las relaciones cara-a-cara, las nuevas tecnologías ejercen una influencia clave en la consecución de relaciones de negocio para distancias cortas, puesto que las relaciones interprovinciales virtuales igualmente suponen un 40% del total llevadas a cabo. A pesar de no poder concluir que las TIC han contribuido a fortalecer las relaciones a corta o larga distancia, el porcentaje total de relaciones tangenciales e internacionales realizados gracias a aparatos electrónicos es superior al del mismo tipo de relaciones realizadas con contacto físico, siendo significativo el caso de las relaciones internacionales llevadas a cabo gracias a las TIC, cuyo porcentaje es el doble que el de las cara-a-cara.

Cuadro 7.
Comparativa de los patrones de negocio de los ICCPs residentes en Castilla La Mancha entre sedes de la misma compañía o entre empresas diferentes

<table>
<thead>
<tr>
<th>Tipo de relación</th>
<th>% relaciones intra-firm</th>
<th>% relaciones inter-firm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jerárquicas con la capital de provincia</td>
<td>0,0</td>
<td>10,5</td>
</tr>
<tr>
<td>Intraprov. con otro municipio de la prov. de residencia</td>
<td>22,7</td>
<td>31,6</td>
</tr>
<tr>
<td>Intermunicipal (total)</td>
<td>22,3</td>
<td>42,5</td>
</tr>
<tr>
<td>Tangencial (con Toledo)</td>
<td>6,8</td>
<td>7,0</td>
</tr>
<tr>
<td>Tangencial (con otro municipio de Castilla La Mancha)</td>
<td>13,6</td>
<td>14,0</td>
</tr>
<tr>
<td>Radial (con Madrid)</td>
<td>20,5</td>
<td>21,1</td>
</tr>
<tr>
<td>Radial (con otro municipio madrileño)</td>
<td>29,5</td>
<td>31,7</td>
</tr>
<tr>
<td>Radial (total)</td>
<td>31,8</td>
<td>24,9</td>
</tr>
<tr>
<td>Internacional (con otras regiones españolas)</td>
<td>25,0</td>
<td>2,8</td>
</tr>
<tr>
<td>Fuente: elaboración propia.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cuadro 8.
Relaciones de negocio cara-a-cara y virtuales de los ICCPs residentes en Castilla La Mancha

<table>
<thead>
<tr>
<th>Type of business relation</th>
<th>Relaciones cara-a-cara (%)</th>
<th>Relaciones virtuales (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intramunicipal (total)</td>
<td>39,5</td>
<td>40,2</td>
</tr>
<tr>
<td>Tangencial (total: con otra provincia de Castilla La Mancha)</td>
<td>24,4</td>
<td>28,0</td>
</tr>
<tr>
<td>Radial (total: con otro municipio de la Región de Madrid)</td>
<td>15,1</td>
<td>15,1</td>
</tr>
<tr>
<td>Inter-regional (con otras regiones españolas, excepto Madrid)</td>
<td>18,6</td>
<td>11,8</td>
</tr>
<tr>
<td>Internacional</td>
<td>2,3</td>
<td>4,7</td>
</tr>
<tr>
<td>Fuente: Elaboración propia.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Conclusiones

Progresivamente, las áreas distantes de regiones metropolitanas multicéntricas han comenzado a ser objeto de interés de recientes investigaciones a nivel urbano y territorial. Tradicionalmente, estas áreas han sido caracterizadas como territorios de paso entre las tradicionales áreas metropolitanas y regiones mucho más distantes, donde las infraestructuras y los servicios de transporte han sido planteadas fundamentalmente bajo criterios radiales desde/hacia el centro metropolitano y no tanto con objeto de conectar territorios dentro de dichas zonas alejadas ni con otros más distantes fuera de la región. Esto significantaria que estas áreas podrían presentar más relaciones con el tradicional área metropolitana.

Los estudios existentes en dichas áreas distantes de Regiones Metropolitanas Multicéntricas han concluido que estos territorios han experimentado durante los últimos años un mayor incremento de movilidad que el del resto de la población nacional. En este caso, al analizar un tipo de profesionales altamente cualificados residiendo en estas áreas distantes, se ha concluido que éstos presentan todavía una mayor movilidad intermunicipal tanto por motivos de commuting como de negocios, incluso cuando un porcentaje importante de ellos reside en municipios de alta centralidad.

Asimismo, el presente análisis concluye que mientras las relaciones de commuting de los hogares residentes en estas áreas son más dependientes del tradicional área metropolitana, las de los ICCP están más diversificadas y abarcan un territorio mayor. Por otro lado, estos profesionales altamente cualificados cuyo trabajo se encuentra en el tradicional área metropolitana, únicamente se desplazan hacia la metrópoli y no hacia ningún otro municipio cercano, posiblemente puesto que es allí donde se encuentran disponibles los empleos de mayor nivel y puesto que se trata de los lugares con una mayor oferta de transporte público (directo). Esto concuerda con García-Palomares (2010:202) quien concluye que para áreas más cercanas a la metrópolis, un alto porcentaje de profesionales con estudios universitarios presentan una fuerte relación con la ciudad central, la cual proporciona un alto número de empleos de alto nivel. Por el contrario, casi un tercio del total de la población de estas áreas que se desplazan a trabajar al área metropolitana lo hace hacia otros municipios cercanos al centro.

Un mayor número de estos profesionales tiende a trabajar en la capital provincial que el resto de la población regional. Para esas profesionales cualificados, la capacidad de polarización de cada capital juega un papel similar al de la metrópolis en la atracción de flujos. Esta mayor atracción de las capitales provinciales significaría que las compañías tienden a localizarse en ciudades con un determinado tipo de servicios y refuerza la hipótesis inicial de la emergencia de nuevas centralidades a nivel regional. Por el contrario, las relaciones intramunicipales no jerárquicas (con otros municipios de la misma provincia de residencia) son menos atractivos para profesionales altamente cualificados (o empresas) para localizar sus lugares de trabajo (sedes). Igualmente, las nuevas capitales regionales de estas áreas juegan un papel mayor para este tipo de trabajadores que para el total de la población (aunque no puede ser comparado con el de las capitales provinciales o el de la metrópolis).

De manera diferente a lo que ocurre con el total de la población regional, la cual presenta unos patrones de desplazamientos por motivos de negocios más
concentrados en un determinado número de municipios y unos patrones de commuting más dispersos, para los profesionales altamente cualificados, la estructura de los viajes de negocios es más compleja, con un mayor número de destinos diferentes y de mayor intensidad a las ligaiones de commuting. Esto significaría que comienza a haber un mayor número de profesionales más cualificados en éstas áreas distantes[7] a medida que estos territorios han comenzado a transformarse de áreas de paso a otras más integradas en procesos metropolitanos y que comienzan a cobrar mayor relevancia. Y como estas áreas presentan una mayor extensión y son menos densas que el tradicional área metropolitana, estos profesionales de alto nivel necesitan viajar a un mayor número de destinos posibles para llevar a cabo sus negocios.

Las nuevas capitales regionales de estas áreas distantes juegan un papel mayor en los desplazamientos de negocios de este tipo de profesionales que para relaciones de commuting, mientras que la metrópoli muestra una capacidad polarizadora similar para ambos motivos de viaje. Sin embargo, todavía es pequeño el porcentaje de negocios de este tipo de profesionales que tiene lugar en estas áreas distantes donde solo la mitad de los flujos tangenciales se dirigen a la capital regional. Esto significa que estas áreas distantes son más multicéntricas que la tradicional área metropolitana (donde el centro metropolitano concentra diez veces más relaciones de negocios que los municipios a una distancia de unos 50 km). Las empresas en estas regiones distantes que contratan profesionales altamente cualificados parecen ser altamente dependientes del núcleo central puesto que las mayores relaciones radiales son entre sedes de la misma compañía.

Desde el punto de vista de las TICs, se podría pensar que en áreas distantes de las Regiones Metropolitanas Multicéntricas su uso (teléfono e email) sería más importante que las cara-a-cara para determinados tipos de relaciones como las tangenciales. Sin embargo, de acuerdo con lo que Dupuy (2002, 2003) y Dijst (2009) concluyen (relaciones virtuales refuerzan en mayor medida las relaciones preexistentes que las nuevas o las que cubren grandes distancias), la distribución de relaciones (intraprovinciales, radiales, tangenciales e interregionales) cara-a-cara y virtuales de profesionales altamente cualificados son similares, con diferencias sustanciales tan solo para las relaciones internacionales. No obstante, dichas relaciones internacionales son muy limitadas en estas áreas distantes, posiblemente porque tienen lugar en mayor medida desde las oficinas centrales localizadas en el centro metropolitano o por otras compañías localizadas en áreas algo más próximas a la metrópoli.

Una de las limitaciones de la presente investigación es la falta de información estadística. Por tanto, tan solo un orientativo análisis diacrónico ha sido posible ser llevado a cabo con el fin de entender la evolución de los patrones de viaje por motivos de negocio de profesionales altamente cualificados residentes en dichas áreas para 2001 (ocupación ocupada con estudios universitarios) y 2012 (ICCPs). Un análisis más detallado sería realmente útil para entender el efecto de las emergentes centralidades en estos territorios distantes de Regiones Metropolitanas Multicéntricas, pero imposible llevar a cabo debido a la falta de información.

Otra de las limitaciones podría ser la alta vinculación de la profesión de ICPPs con actividades del sector público, por lo que siguiendo la sugerencia de Alexander y Dijst’s (2012) de desarrollar un análisis para diferentes tipos de profesionales, una vez la metodología ha sido probada, la investigación en un futuro podría/debería extender el análisis a otros tipos de profesionales menos ligados a este sector, incluyendo igualmente otros motivos de viaje (discrecionales) los cuales están ganando relevancia en los patrones de movilidad.

Notas
[1] Tal y como definen Millary y Salt (2008), se consideran viajes de negocios aquellos que suponen trabajar en una oficina diferente a la habitual por menos de un mes y donde las tareas llevadas a cabo son reuniones de proyectos o con la finalidad de instruir a alguien, siendo necesario el contacto físico en una localización diferente. Según Aguilera (2008), se trata de viajes que por motivos laborales se realizan hacia un lugar diferente al habitual de trabajo, como visitar a un cliente, participar en una conferencia o asistir a una reunión.
[3] Otras tres autovías regionales han sido construidas en los últimos años: la A-41 entre Ciudad Real y Puertollano, la CM-45 desde Ciudad Real hacia el sureste de la provincia y el tramo de la A-40 entre Toledo y Tomelloso. Sin embargo, puesto que tan solo permiten flujos intraprovinciales, no pueden considerarse infraestructuras tangenciales (entendiendo como tal aquellas que permiten flujos entre las diferentes provincias de Castilla La Mancha).
[5] Albertos et al. (2007) concluyeron que los profesionales altamente cualificados y con altos salarios presentaban las mayores tasas de movilidad intermunicipal. Por ej., para la Comunidad Valenciana, la movilidad intermunicipal representa el 46% para Arquitectos e Ingenieros.
[7] El número de universitarios graduados en Castilla La Mancha era proporcionalmente menor en que España pero han incrementado de manera considerable en los últimos años. Eran algo más pequeños en 2005 (38 frente a 133 por cada 1000 hab.) y han aumentado entre 2005 y 2013 proporcionalmente más rápido que en España (multiplicado por 1,2 frente a 1,15) de acuerdo a las Encuestas de Población Activa de 2005 y 2013. Pastor y Perera (2010) muestran igualmente que en CLM los ocupados con estudios universitarios aumentaron más rápidamente en CLM que en España entre 1995 y 2008.

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LIMITANAKOOL, N., DIJST, M., and SCHWANEN, T. A Theoretical framework and methodology for characterising national urban systems on the basis of flows
Ficha bibliográfica:

Distant areas of multicentric metropolitan regions households’ functional relationships: radial versus tangential mobility patterns

Abstract

Transport networks strongly influence settlement structures and vice versa, while their improvements during the last decades have played a key role in increasing polycentric region’s size and complexity.

In monocentric metropolitan areas having evolved into polycentric, with their central core still playing a crucial role, personal movements are not only radial but also tangential.

This paper characterizes mobility (work and non work-related) evolution within distant areas of Polycentric Metropolitan regions and between them and the traditional metropolitan areas in contexts where the metropolis still plays a crucial role, the distant areas have been transformed into politico/administrative regions and transport networks are becoming radio-concentric. The paper studies to what extent mobility patterns have evolved towards polynodal.

The Madrid province and its adjacent Castilla-La Mancha region are taken as a case study. The paper compares the evolution during the last three decades of radial relations with Madrid and tangential relations within Castilla-La Mancha. Special attention is given to relations with Toledo, upgraded in 1982 from a provincial to the regional capital.

Commuting data is obtained from 1981 and 2001 census, while other travel information (commuting, shopping, health care, specialized services and business trips) from two household surveys of one Castilla-La Mancha province carried out in 1980 and 2006 and from a similar 2012 household survey undertaken by the authors on all five regional provinces including the same mobility questions.

The empirical findings show that although intraprovincial and radial flows remain as the most important ones for all trip purposes, tangential relations start developing, more strongly in business related matters than on commuter or service related ones.
1. INTRODUCTION

Transport networks strongly influence economic development, settlement structures and mobility patterns and vice versa (Biehl, 1991; Offner, 1993; Fröidh, 2005; Ureña, 2012) and their improvements during the last decades have played a key role in increasing polycentric region’s size and complexity. Specific studies have proven the relation between mobility pattern changes and city systems morphology, land-use densities and urban design (Clark and Kuijpers-Linde, 1994; Cervero, 1996; Schwanen et al., 2001; Chai et al., 2011). Present research interest is being enlarged to include socio-economic characterization of movements and movers (Meurs and Haaijer, 2001; Módenes, 2007; Malcata, 2012).

Traditionally city systems were characterized by oil stain (Harris and Ulman, 1945) and monocentric growth models (Mayer and Wade, 1969), with metropolitan areas characterized by a central core and suburban or satellite areas. However, during the 20th century they have progressively evolved towards decentralization and balanced territorial growth, both near the metropolitan areas as well as on less developed further away regions, in both cases well connected to transportation networks, generating polycentric structures.

This is taking place in parallel to and thanks to an increased mobility facilitating workplaces and workers location in different places and according to different rationales. This growing separation between origins and destinations (Bannister, 1999; Findlay et al., 2001) results in greater distances travelled to access workplaces (Rouwendal and Rietveld, 1994; Levinson, 1998; Ascher, 2004; Banister, 2008) and also shopping, leisure or social activities (Gordon et al., 1988; Giuliano, 1998; Schwanen et al., 2001; Miralles-Guasch and Tulla Pujol, 2012). This is increasing mobility complexity and use of private car (Giuliano, 1998; Aguilera and Mignot, 2002), more so in the outer metropolitan crowns where public transport is usually weaker (Gutiérrez-Puebla and García-Palomares, 2005).

The precise urban structure, the functional pre-existing relations, the transport network evolution and the political-administrative structure are crucial to understand each territory mobility patterns (Martínez, 2010).

In areas evolving towards Polycentric Metropolitan Regions the relations with the traditional metropolis are losing relative importance and being complemented by relations with subcentres and the proximity to the metropolis is not any more the only/main residential and/or job location criteria (Filion et al., 1999). The proximity to the other subcentres also becomes substantial. In these spatial contexts, mobility patterns are evolving from internal radial relations to the central core in limited metropolitan areas and almost independent adjacent territories (Figure 1A), towards extended

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1 In the Netherlands, travel to work represents only one fifth of all trips and the daily commuting distance only one fourth of the total one (Schwanen et al., 2001).
metropolitan areas with radial relations with a larger number of more distant nucleus (Figure 1B) and towards polycentric metropolitan regions with multiple relations between a larger number of poles, producing dispersed (Clark and Kuijpers-Linde, 1994; Gutiérrez and García-Palomares, 2007) or nebulous mobility patterns (Nel-Lo, 1998), with centripetal and centrifugal radial relations (Giuliano and Gillespie, 1997; Aguiléra et al., 2009) and tangential periphery-periphery ones (Clark and Kuijpers-Linde, 1994; Talbot, 2001; Massot and Roy, 2004) (see Figure 1).

The objective of this research is to explore if interaction patterns occurring within traditional metropolitan boundaries, during the last decades, start characterising also more distant areas. That would mean that new horizontal/tangential relations are emerging between distant/peripheral subcenters together with radial and other hierarchical relations.

Figure 1. – Mobility patterns evolution between the traditional metropolitan area and the distant territories integrated in present polycentric metropolitan regions. Source: authors.

The aim of this paper is double. First, to characterize mobility patterns evolution within distant/peripheral areas (further away than traditional metropolitan areas, approximately between 50 and 250 km from the metropolis) progressively being integrated into Polycentric Metropolitan regions and between them and the traditional metropolitan areas, in contexts where the main previous metropolitan core still plays a crucial role, the distant/peripheral areas have been transformed into politico/administrative regions with the emergence/reinforcement of new centralities and the
transport improvements have changed the network from radial to radio-concentric. Second, to study to what extent these mobility patterns have evolved from a predominantly central core radial model towards a polynodal one.

The central area of Spain is considered as a case study, covering the region/province of Madrid and the region of Castilla-La Mancha (five provinces) (two NUTS-2, European ‘Nomenclature of Units for Territorial Statistics’). The traditional monocentric Madrid metropolitan area has undergone profound dispersion and deconcentration processes (Solís et al., 2012) and relevant changes in mobility patterns (García-Palomares, 2010) with monocentrism evolving towards polycentrism (Gallo et al., 2010) and to dispersed and complex functional relations (Monzón and de la Hoz, 2009) along greater geographic and time distances (Gutiérrez and García-Palomares, 2007).

The paper is organized into five sections. The second one compiles the results of previous research studies focused in understanding the complex link between spatial urban structures and functional relations. The third one presents the case study, the information sources used in the analysis and the methodological approach. The fourth section discusses the evolution of work and non-work related travel during the last three decades for Castilla-La Mancha, considered a distant area (up to 250 km far away the metropolis) of the Madrid Metropolitan Region. The final section summarizes the conclusions.

2. LITERATURE REVIEW. NEW URBAN AND MOBILITY PATTERNS

The relation between mobility and urban form has mainly been studied through labour commuting flows as a measure of functional territorial relations, since they constitute the greatest daily recurrent travel (Burger et al., 2011). There are abundant Spanish studies using this information1 (Casado-Díaz, 2000; Salom and Delios, 2000; Castañer et al., 2000; Albertos Puebla et al., 2007; Feria Toribio and Albertos Puebla, 2010; Romani and Casado, 2010; Reques, Cos and Marañón, 2012) and international ones (Clark and Kuijpers-Linde, 1994; Green, 1995; Cervero, 1996; Sick Nielsen and Harder Hovgesen, 2008; Hincks and Wong, 2010), many of them focusing on congestion issues in metropolitan areas.

Many of these studies analyse if metropolitan urban sprawl and polycentrism change functional relationships in terms of travel distances, times and modes (Green, 1995; Titheridge and Hall, 2006), and if new subcentres facilitate ‘co-location’ (relocation and clustering) of employments and population within the periphery. Some studies conclude that new polycentric urban regions diminish commuting distances and times, supporting co-location (Gordon et al., 1986; Gordon et al., 1991; Giuliano and Small, 1990).

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1 In Spain studies are focused on a) delimiting functional territories using daily flows (areas of urban influence, metropolitan areas or labour market areas), b) identifying life spaces and c) level of territorial interaction regarding housing, jobs or studies.
1993), while others arrive to the opposite conclusions (Cervero and Wu, 1998). Levinson (1998) concludes that job decentralization/relocation maintains commuting times and increases distances and congestion. Recent studies debate if present urban patterns reduce commuting or create excess commuting (Frost et al., 1998; Ma and Banister, 2006), and suggest that, even with transport improvements, urban dispersion and polycentrism increases commuting distances and dependence on private cars (García-Palomares, 2010) and that co-location only happens for a minority of persons (Aguilera, 2005).

Schwanen et al., (2001) for different travel purposes indicate that deconcentration in monocentric and polycentric structures increases private car travel, while distances increase in monocentric structures and not necessarily in polycentric ones. Burger et al. (2011) analyse labour commuting patterns inside 22 English and Welsh city-regions, but not with London or between the different regions, through morphologic and functional approaches between 1981 and 2001 concluding that those regions around London (South-East and Midlands) are internally evolving towards polycentric structures while the northern ones are not changing.

Some studies on polycentrism and commuting patterns compare average labour commuting distances towards the central city and towards employment subcentres although conclusions are very different. Cervero & Wu (1997) for San Francisco conclude that distances are smaller towards subcentres. Gordon, Richardson and Wong, (1986) for Los Angeles conclude that residents of subcentres distances are bigger that those of the central city. Aguilera (2005) for Paris, Marseille and Lyon conclude that most subcentres have more jobs than inhabitants but nevertheless their inhabitants commute to other municipalities, thus increasing labour commuting distances. Previously, Aguiléra and Mignot (2004) had concluded that subcentres reorganize mobility depending on their type, size and proximity to the central city.

Reconsidering if labour commuting is explained by urban structures, Giuliano and Small (1993) conclude that there must be other factors that have greater influence since travel times are greater than minimal. Following this rationale, Cervero and Kockelman (1997) studied if the 3D's (urban density, diversity and design) influence mobility patterns, and several others studied the relation between built up areas characteristics and travel behaviour (Boarnet and Sarmiento, 1998; Schwanen et al., 2001; Cervero 2002, 2006; Giuliano and Narayan, 2003; Vilhelmson, 2005; Cattaneo, 2006; Le Néchet, 2012). Most recent approaches include two variables: a) household and family structure (Giuliano et al., 1997; McQuaid, 2009) and b) population socio-economic characteristics (Casado-Díaz, 2000; Titheridge and Hall, 2006; van de Coevering and Schwanen, 2006; Albertos et al., 2007; Susino et al., 2007; Romani and Casado, 2010).

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1 In a previous study of how employment relocation influence commuting patterns, Cervero and Landis (1991) concluded that distances remain similar and travel times were reduced considerably.
During the last decade, an increasing number of flow studies focus on new urban spatial structures. Some suggesting a typology (central, decentral, cross-commuting and exchange-commuting) of daily urban travel based on the degree suburbs attract commuters from other suburbs or the central city (van der Laan, 1998). Others about Functional Urban Regions, Limtanakool et al., (2007a) study strength, intensity and symmetry/dissymmetry of flows by using labor commuting and also business, vacation and leisure flows to analyze in 2001 several French and German Functional Urban Regions up to 100 km distances. Later on, Limtanakool et al., (2009), using the same methodology, analyze 23 Daily Urban Systems in The Netherlands, looking at work related and leisure travel and concluding that polycentrism is growing, more so at intraregional scale (Randstad), that labour commuting distances increase and leisure ones decrease. To consider the nodes characteristics and their influence on mobility patterns Limtanakool et al., (2007b) analyze city-positions within urban systems (ranking and comparing 39 metropolitan areas in Western Europe) combining an interaction analysis (business and holiday flows) and a node attribute one (socio-demographic, accessibility, economic and tourism features).

For a wider scale, Hall and Pain (2006) describe inter-city relations within eight Mega-City Regions (not including Madrid or Barcelona) understanding not only inter-city relations within each one to show how they are integrated, but also the relative importance of cities within their regions (ranking cities in each region regarding intra-regional and global network connectivity). They use three indexes: the ‘closure degree’, as the number of workers residing within the same Functional Urban Region (FUR) and the ‘in-commuting value’ and the ‘out-commuting value’ as the attraction/generation of workers to/from each FUR, differentiating between the central one and all others. Although this research covers distant territories from the metropolis, it only carries out a static analysis. Similar mobility analyses differentiating among travel within the central area, within peripheral/distant regions and between both of them, have been carried out by Gilli (2005) for the ‘Parisian’ basin and de Goei et al. (2010) for the Greater South East of England (up to 150-180 km far away London). Juaristi (2003) studies the Basque Country urban structure evolution (1991 to 1996) through commuting flows distinguishing two types of nodal structures, principal and secondary flows destinations from each municipality, concluding that principal hierarchies have not changed maintaining centripetal structures, while the secondary one has changed, with more secondary poles, less traditional secondary poles relevance and new dispersed secondary destinations.

As indicated previously very few studies use other types of travel (Aragay, 1995; Schwanen et al., 2001; Limtanakool et al., 2007a and 2009; Alcantara de Vasconcellos, 2005; Aguilera et al., 2009) which are less regular and recurrent (Pazos Otón, 2005a). Nevertheless, since employment is getting less

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1 Although the analysis covers French regions further away the national capital, Paris, and categorizes the space in terms of mobility patterns (links with Paris, other local spaces or surrounding/near cities), it is done only taking commuting travel into account and does not consider changes over time.

2 It is called as the Parisian Basin the socio-economic space under the influence of Paris.


4 Juaristi (2011) extends the study period to 2001 and includes distance friction and entropy factors.
spatially clustered, the relevance of studying other labour related less recurrent travel, such as business (Aguilera et al., 2009), increases. Another reason is that total daily travel growth is recently based more on these other travel purposes (in the Madrid region Ureña and Muruzábal (2006) show that between 1996 and 2004 commuting travel increased by 32.3% while all other types of personal travel increased by 88.3%). Nevertheless, these other trips are greatly influenced by labour and educational commuting (Aguilera, et al., 2009), and often take place around the employment or the residence location or in between, especially if they have an important recurrence (Baht, 1997; Hanson, 1980). Moreover, they depend on each municipal centrality level and urban form and on personal characteristics (socio-economic, leisure attitudes, familial and friends) (Aragay, 1995), and abundant labour commuters undertake an intermediate stop not related to work (McGuckin and Srinivasan, 2005). Aguilera et al., (2009) show that travel of non employed persons is shorter and takes place within the home municipality or nearby.

The present paper adds to previous studies by analyzing the evolution of internal/external and labor/non-labor related flows of distant areas of metropolitan polycentric regions (from 50 to 250 km, see Figure 1). It also adds by considering distant areas of metropolitan regions that have been transformed into political regions, and by studying the role of the new regional capital. The paper debates to what extent the metropolitan core is still leading mobility patterns in these distant areas or if new flows are emerging among their cities, in particular with/among provincial capital (Historic Administrative Cities) and the new regional capital, and to what extent this happens more for certain travel purposes.

3. CASE STUDY, DATA AND METHODOLOGY

3.1. A DISTANT AREA OF THE MADRID MULTINODAL METROPOLITAN REGION AS A CASE STUDY

Mobility patterns in metropolitan areas and the underlying new urban systems will be studied by using a distant/external part of the Madrid Multinodal Metropolitan Region (Pillet et al., 2010; Solís, 2012). During the 1950’s and 1960’s Madrid consolidated a dual metropolitan model with a centre and a close by dependant periphery. Since 1980’s, in parallel with important transport infrastructure investments and with activities decentralization, new economic poles started to emerge and the monocentric model started to evolve towards a multicentric one (Gallo et al., 2010). The spreading effects started to overflow beyond the Madrid region administrative limits, producing functional interrelations/articulations between its central area and the adjacent provinces\(^1\).

---

\(^1\) In 2004, the central area of Madrid concentrated the 54% inhabitants living in the whole province and the 70% of the workplaces existing within the autonomous region boundaries (García-Palomares and Gutiérrez Puebla, 2007).
The study area covers two regions, Madrid (one province) and Castilla-La Mancha (5 provinces) traditionally influenced by Madrid due to the absence of strong urban centres (see Figure 2). Castilla-La Mancha has been defined as disorganized, without functional cohesion (Pardo, 1996) and acephalic/leaderless (Cebrián and Cebrián, 2000; Cebrián, 2007).

Each Castilla-La Mancha province has its own peculiarities (see Figure 2 and Table 1). Toledo province is adjacent to Madrid, its regional capital Toledo is further south and has another major city, Talavera de la Reina (see Figure 3), further to the west. The province of Guadalajara is also adjacent to Madrid with its capital, Guadalajara, very close to the administrative boundary. These two provinces are clearly influenced by the metropolitan processes with some of their municipalities closer to Madrid having grown as a consequence. The province of Ciudad Real, south of Toledo, has a polycentric structure, its capital city Ciudad Real representing only 14% of the total provincial population. The province of Cuenca is east of Madrid and its only city and capital Cuenca is rather small. The province of Albacete is south of Cuenca and east of Ciudad Real and more distant from Madrid, with traditional relations to the Mediterranean coast, its capital Albacete is the biggest regional city.
## Table 1. - Population evolution of Castilla-La Mancha provinces and capital cities. Source: authors based on INE.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Albacete (Capital)</td>
<td>117,126</td>
<td>149,507</td>
<td>172,472</td>
<td>43</td>
</tr>
<tr>
<td>Rest of the Albacete province</td>
<td>174,360</td>
<td>143,449</td>
<td>147,146</td>
<td>37</td>
</tr>
<tr>
<td>Albacete province (total)</td>
<td>334,468</td>
<td>367,283</td>
<td>402,837</td>
<td>100</td>
</tr>
<tr>
<td>Ciudad Real (Capital)</td>
<td>51,118</td>
<td>61,280</td>
<td>74,921</td>
<td>14</td>
</tr>
<tr>
<td>Rest of the Ciudad Real province</td>
<td>291,676</td>
<td>284,959</td>
<td>301,035</td>
<td>57</td>
</tr>
<tr>
<td>Ciudad Real province (total)</td>
<td>468,327</td>
<td>478,581</td>
<td>530,250</td>
<td>100</td>
</tr>
<tr>
<td>Cuenca (Capital)</td>
<td>41,791</td>
<td>46,491</td>
<td>57,032</td>
<td>26</td>
</tr>
<tr>
<td>Remaining mun. &gt; 20,000 inhab. [No]</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Rest of the Cuenca province</td>
<td>167,207</td>
<td>155,035</td>
<td>161,004</td>
<td>74</td>
</tr>
<tr>
<td>Cuenca province (total)</td>
<td>208,998</td>
<td>201,526</td>
<td>218,036</td>
<td>100</td>
</tr>
<tr>
<td>Guadalajara (Capital)</td>
<td>56,922</td>
<td>67,640</td>
<td>84,803</td>
<td>33</td>
</tr>
<tr>
<td>Rest of the Guadalajara province</td>
<td>48,097</td>
<td>83,509</td>
<td>139,588</td>
<td>54</td>
</tr>
<tr>
<td>Guadalajara province (total)</td>
<td>105,019</td>
<td>171,532</td>
<td>259,537</td>
<td>100</td>
</tr>
<tr>
<td>Toledo (Capital)</td>
<td>57,769</td>
<td>69,450</td>
<td>84,019</td>
<td>12</td>
</tr>
<tr>
<td>Rest of the Toledo province</td>
<td>349,901</td>
<td>390,670</td>
<td>513,873</td>
<td>72</td>
</tr>
<tr>
<td>Toledo province (total)</td>
<td>471,806</td>
<td>536,131</td>
<td>711,228</td>
<td>100</td>
</tr>
<tr>
<td>Castilla-La Mancha Region (total)</td>
<td>1,588,618</td>
<td>1,755,053</td>
<td>2,121,888</td>
<td>100</td>
</tr>
</tbody>
</table>

## Table 2. - Evolution of road travel times between the five main cities (Years 1981-2012). Source: authors.

<table>
<thead>
<tr>
<th>City</th>
<th>1981 (min)</th>
<th>∆(81-12) (%)</th>
<th>1981 (min)</th>
<th>∆(81-12)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albacete</td>
<td>134</td>
<td>-19%</td>
<td>112</td>
<td>-25%</td>
</tr>
<tr>
<td>Ciudad Real</td>
<td>145</td>
<td>-31%</td>
<td>159</td>
<td>-16%</td>
</tr>
<tr>
<td>Cuenca</td>
<td>83</td>
<td>0%</td>
<td>99</td>
<td>-22%</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>34</td>
<td>-27%</td>
<td>80</td>
<td>-26%</td>
</tr>
<tr>
<td>Madrid</td>
<td>47</td>
<td>-23%</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*APPENDIX IX – PAPER A.7*
Castilla-La Mancha has been considered as a ‘crossing region’ (Pillet et al., 2010) where transport investments, mainly in national networks, have conditioned its urban dynamics (Cebrián, 2007). Transport improvements during the last decades have transformed the radial road/rail infrastructures towards a radio-concentric one inside the Madrid province/region, but within Castilla-La Mancha it is still preponderantly radial. Transport network major changes have been (see Figure 2): 1) upgrading radial national roads to motorways along all the study area (and duplicating a few corridors), 2) building four new orbital (or semi-orbital) motorways within the Madrid province/region (M-30, M-40, M-45 and M-50) and 3) creating three tangential motorway stretches\(^1\) crossing West to East Castilla-La Mancha (CM-42, A-43 and A-40). Despite the road network most road travel times, radial and tangential, have been reduced (see Table 2). The rail network has reduced the number of traditional rail services, extended suburban rail to cities just outside the Madrid region and created High-speed Rail connections between each Castilla-La Mancha provincial capital and Madrid\(^2\) (Mohíno et al., 2012).

Most previous studies focusing on mobility at the central area of Spain (Gutiérrez Puebla and García-Palomares, 2005; García-Palomares, 2010; García-Palomares and Gutiérrez Puebla, 2007; Gallo et al., 2010, Monzón and de la Hoz, 2009) limit their analyses to the Madrid province (approximately 50 km from Madrid), only a few consider a more distant territory (Pillet et al., 2010; Solís et al., 2012), and due to data constraints they are limited to 20-year period changes (1981-2001) in travel-to-work flows. The present study understands thirty year evolution (1981-2012) of work and non-work related travel of a territory reorganized into a politico-administrative region distant from the traditional metropolitan center and where transport improvements have been mainly radial, with very few tangential new links.

3.2. DATA AND METHODOLOGY

The paper compares the evolution of flows from 1981 to 2012. Intermunicipal labour commuter flows from census are available only for two years: 1981 (disaggregated data is available only from each municipality towards municipalities bigger than 20,000 inhabitants) and 2001 (between all municipalities). A mobility survey has been undertaken by the authors to understand travel patterns occurring in 2012. Surveying the whole population was impossible to undertake, thus, 20 municipalities\(^3\)

---

\(^1\) Three other high capacity road infrastructures have been created: the A-41 between Ciudad Real and Puertollano, the CM-45 from Ciudad Real towards the Southeast of the province and the A-40 section between Toledo and Torrijos. However, since they allow intraprovincial flows, they are considered apart from those infrastructures allowing real tangential flows between different Castilla-La Mancha provinces.

\(^2\) There exists only three exceptions of High-speed Rail tangential relations between regional cities: between Ciudad Real and Cuenca (which only has one service per day in each direction), between Cuenca and Albacete and between Ciudad Real and Puertollano (this one non significant in originating new horizontal flows due to the also recent motorway connecting both centers).

\(^3\) These municipalities (see Fig. 3) were chosen according to the following criteria: 1. Their geographical location in order to achieve a set of check points homogeneously distributed throughout the region; 2. Their ‘size’ in terms of population and the existence of at least a High School; 3. Their positive demographic dynamics during the last 30 years (1981-2011) and 4. Their capability to articulate surrounding areas (in that sense, five of the chosen municipalities where under the population threshold selected of 10,000 inhabitants in 2011, but were included due to their role in organizing the adjacent territory).
were selected (see Figure 3) to characterize households’ mobility\(^1\) following previous studies methodologies (Pazos, 2005; Garmendia, 2008)\(^2\).

A test on the accuracy in obtaining Castilla-La Mancha 2012 mobility pattern by surveying only 20 municipalities in 2012 was undertaken prior to accepting this procedure. The test consisted in extrapolating 2001 census data mobility of the surveyed municipalities to the other similar non-surveyed municipalities (in terms of population size, location and centrality) and compare them with their 2001 census data mobility. The results confirmed that the flows obtained from each procedure were sufficiently similar\(^3\), thus it was accepted to survey only 20 municipalities.

The questionnaire was based on those elaborated by Piillet et al. (1980) and Garmendia (2008) in order to compare with the mobility patterns of their two previous temporal scenarios. Two main parts can be distinguished: one aimed at collecting basic information about the head of the surveyed

\(^1\) The sample size of each municipality was calculated to obtain a 7% margin of error at a 95% level of confidence.

\(^2\) An own elaborated questionnaire was addressed to high school students to be completed at their households. In those cases were the number of registered students was not enough to achieve a representative sample, the questionnaire was also distributed among students in the last two years of Primary School. In those municipalities were the population in 2011 was under the 10,000 inhabitants threshold, three questionnaires were handed to each student to be completed by their relatives. 7345 surveys were completed and once the answers were analyzed, rejecting invalid ones, 6913 valid answers were gathered for the whole region. Despite the bias produced by focusing on a certain group of the population (families with school-age children), this sector has high levels of mobility, being one of the most attractive for the study.

\(^3\) For instance, mobility patterns of Tomelloso and Quintanar de la Orden, in terms of population and their centrality role (both between 10,000 and 50,000 inhabitants and a medium centrality level) could be expanded with the ones of Alcázar de San Juan. Regarding labour linkages this is confirmed since they have their main interactions between Madrid and other near municipality of the same province.
households and the other to obtain information about the different generated trips for each purpose: commerce, health services and business.

The territorial articulation of the distant part of the Madrid Multicentric Metropolitan Region, will be addressed under a double approach:

On the one hand, work-related regional mobility patterns. Labor commuting is considered for three different temporal scenarios (1981, 2001 and 2012) in order to understand the organization of flows and the consolidation or emergence of centers in the urban system. Firstly, in absolute terms (the strength of interaction) as the number of trips originated from each municipality. This first analysis identifies cities playing a key role in regional mobility patterns. Secondly, in relative terms (percentage of trips originated from each center) to understand the re-configuration of the importance/centrality of destination centers. As well as labor commuting, another less frequent work-related travel is considered, business purpose travel. This is done by comparing the province of Ciudad Real the evolution\(^1\) of those interactions between 2006 and 2012, by characterizing them for the whole region in 2012 and by comparing their structure with that of commuting travel in 2012.

On the other hand, by focusing on non-work related travel (absolute and relative terms), in comparing for the province of Ciudad Real their structure of flows for 1980, 2006 and 2012, and by analyzing their 2012 structure for all the region.

All analyses will classify the flows according to the centers they are directed to (see Figure 4):

a) Hierarchical relationships with the provincial capital
b) To other municipalities of the same residing province, different from the capital city.
c) Intra-provincial (as the sum of the two previous ones)
d) Tangential relationships with the regional capital (Toledo)
e) Tangential relationships with other Castilla-La Mancha provinces (excluding the regional capital)
f) Total tangential relationships
g) Radial relationships with Madrid
h) Radial relationships with other Madrilenian municipalities (excluding the capital)

\(^1\) It is not possible to compare with the situation in 1980 since this type of flow was first introduced in the 2006 questionnaire (Garmendia, 2008).
i) Total of radial relationships directed to any Madrilenian municipality
j) Inter-regional relationships with other Spanish regions, excluding Madrid

Finally, the article distinguishes between determinant intermunicipal flows of more than 50 persons and representing more than 10% of all out-flows from each municipality and all the other less important flows. Among the determinant ones, the most numerous one from each municipality is classified as primary and all the others as secondary.

4. RESULTS: FLOWS EVOLUTION AND MOBILITY PATTERNS

4.1. EVOLUTION OF WORK RELATED FLOWS: TOWARDS MULTIDIRECTIONALITY

Very few studies use business travel flows (Faulconbridge et al., 2009) because there is no data and because they represent only a small proportion of daily travel. In USA in 1995 they represent only one third of what labour commuting represents (Nelson & Niles, 2000), while business travel has increased in frequency (Urry, 2003). The interest in comparing commuting with business travel is because it seems that the later reorganizes spatially more rapidly and is more flexible than labour commuting (Burger et al., 2011) and thus it may point out future more profound spatial reorganizations.

This section's results show that Castilla-La Mancha labour commuting remains predominantly hierarchical with the provincial capital or radial, while business flows are also tangential and interregional. Therefore, it can be concluded that polycentrism that already exists near Madrid (Gutiérrez and García Palomares, 2007) is also getting built in distant parts of the Madrid Multinodal Metropolitan Region.

4.1.1. Labour commuting patterns

A. Increasing labour outwards mobility

Intermunicipal labour commuting has increased tremendously both in numbers and in destinations between 1981 and 2012 (see Table 3 and Figure 5.a.).

Total intermunicipal outward labour flow figures for 2001 and 2012 multiply by 2-10 times and by 3-20 times, respectively, those of 1981 (see Table 3). This outstanding intermunicipal labour flows increase is greater1 to that already described in general in Spain (Castañer et al., 2000). The duplication of both car ownership ratio, from 0.28 cars/person in 1981 to 0.67 cars/person in 2011 (DGT, 2008 and 1 Between 1986 and 1996, for the Catalonian case, labour commuting almost doubled from 529,152 inhab. to 923,443 inhab. (Castañer et al., 2000) similarly to the increased for the Valencian Region between 1991 and 2001 (Albertos et al., 2007).
and female working ratio, from 26.8% in 1981 (Martín, 2000) to 52.9% in 2002 (INE, 2011), have facilitated this increase, making it more easy to work in other municipalities and more difficult to find work for both persons in a couple in the same municipality. In the case of Castilla-La Mancha this increase was also facilitated by a reduction in many time distances (around 20%, see Table 2) and its progressive integration into metropolitan processes.

There is also a profound increase in intraprovincial intermunicipal labor commuting between 1981, 2001 and 2012, this increase being, in general, greater with the provincial capital –hierarchical relations- than with the rest of the province\(^1\) (see Table 3). Nevertheless, it seems there is no relation between this increase and the distances to Madrid and each provincial capital.

The municipality that presents the highest intermunicipal and intraprovincial interactions (in absolute terms) for the three time scenarios is Guadalajara, which could be explained by its proximity to Madrid (see Table 6). Nevertheless, it is the capital of the more polycentric province (Ciudad Real) the one with highest intraprovincial flows in relative terms. The same can be concluded for the whole province: those ones with a more polycentric structure have higher percentages of flows within the same province (56.4% of the total outward in 2001 and 65.9% in 2012 for the province of Ciudad Real) than the other ones with a more monocentric model (40.9% of the total outward in 2001 and 44.5% in 2012 for the province of Guadalajara).

---

\(^1\) Between 1981 and 2001, 10 out of 15 considered municipalities (excluding the five capital cities), and 11 out of 1 between 2001 and 2012, have greater increases towards their respective provincial capital city.
### Table 3. - Increases of outward commuting from surveyed municipalities. Source: INE and authors.

<table>
<thead>
<tr>
<th>Municipality</th>
<th>Distance to Madrid (km.)</th>
<th>Distance to the prov. capital city (km.)</th>
<th>Inhabitants working outside their municipality as % of their total population working in cities / Total working outside</th>
<th>Increase of hierarchical relations towards the capital city</th>
<th>Increase of total intraprovincial relations</th>
<th>Increase of radial relations towards Madrid</th>
<th>Increase of radial relations towards metropolitan subcenters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Azuqueca de Henares</td>
<td>47.6</td>
<td>16.6</td>
<td>3.00</td>
<td>24.74</td>
<td>26.43</td>
<td>7.8</td>
<td>2.2</td>
</tr>
<tr>
<td>Casar (El)</td>
<td>49.5</td>
<td>28.2</td>
<td>6.17</td>
<td>29.25</td>
<td>32.01</td>
<td>7.7</td>
<td>2.2</td>
</tr>
<tr>
<td>Guadalajara</td>
<td>58.1</td>
<td>-</td>
<td>4.39</td>
<td>13.29</td>
<td>16.75</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Ocaña</td>
<td>64.0</td>
<td>61.8</td>
<td>1.06</td>
<td>9.26</td>
<td>21.58</td>
<td>5.4</td>
<td>3.3</td>
</tr>
<tr>
<td>Toledo</td>
<td>74.2</td>
<td>-</td>
<td>1.33</td>
<td>6.64</td>
<td>14.83</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Tarancón</td>
<td>82.2</td>
<td>83.8</td>
<td>1.50</td>
<td>6.65</td>
<td>10.50</td>
<td>*</td>
<td>3.9</td>
</tr>
<tr>
<td>Torrijos</td>
<td>94.2</td>
<td>31.5</td>
<td>4.54</td>
<td>12.64</td>
<td>21.14</td>
<td>4.4</td>
<td>3.8</td>
</tr>
<tr>
<td>Madridejos</td>
<td>121.1</td>
<td>73.9</td>
<td>3.17</td>
<td>13.80</td>
<td>20.11</td>
<td>1.4</td>
<td>5.1</td>
</tr>
<tr>
<td>Talavera de la Reina</td>
<td>128.0</td>
<td>90.1</td>
<td>2.18</td>
<td>6.30</td>
<td>10.57</td>
<td>11.7</td>
<td>2.5</td>
</tr>
<tr>
<td>Sigüenza</td>
<td>129.8</td>
<td>73.9</td>
<td>1.86</td>
<td>7.47</td>
<td>6.08</td>
<td>10.0</td>
<td>1.1</td>
</tr>
<tr>
<td>Mota del Cuervo</td>
<td>149.1</td>
<td>128.6</td>
<td>2.02</td>
<td>7.96</td>
<td>10.05</td>
<td>*</td>
<td>1.1</td>
</tr>
<tr>
<td>Alcázar de S. Juan</td>
<td>150.8</td>
<td>117.1</td>
<td>0.82</td>
<td>7.13</td>
<td>12.78</td>
<td>17.8</td>
<td>7.9</td>
</tr>
<tr>
<td>Cuenca</td>
<td>165.4</td>
<td>-</td>
<td>1.52</td>
<td>4.24</td>
<td>8.20</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Valdepeñas</td>
<td>203.1</td>
<td>61.5</td>
<td>0.47</td>
<td>3.56</td>
<td>7.03</td>
<td>3.5</td>
<td>5.1</td>
</tr>
<tr>
<td>Villarrobledo</td>
<td>210.9</td>
<td>87.4</td>
<td>0.51</td>
<td>4.09</td>
<td>4.70</td>
<td>7.3</td>
<td>2.5</td>
</tr>
<tr>
<td>Motilla de Palancañar</td>
<td>213.0</td>
<td>66.1</td>
<td>1.37</td>
<td>5.42</td>
<td>5.87</td>
<td>*</td>
<td>4.3</td>
</tr>
<tr>
<td>Ciudad Real</td>
<td>224.7</td>
<td>-</td>
<td>0.95</td>
<td>6.62</td>
<td>10.51</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Albacete</td>
<td>251.9</td>
<td>-</td>
<td>0.86</td>
<td>3.95</td>
<td>4.05</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Puertollano</td>
<td>262.7</td>
<td>40.8</td>
<td>0.47</td>
<td>5.03</td>
<td>5.56</td>
<td>9.5</td>
<td>1.8</td>
</tr>
<tr>
<td>Almansa</td>
<td>324.9</td>
<td>73.4</td>
<td>1.93</td>
<td>3.83</td>
<td>6.61</td>
<td>13</td>
<td>4.4</td>
</tr>
</tbody>
</table>
Total radial labour commuting towards Madrid region has also experienced a profound increase. It was small in 1981, although greater in municipalities closer to Madrid, almost exclusively directed to the Madrid municipality, with very small flows to other Madrid province municipalities and only from Castilla-La Mancha municipalities very close to them (see Figure 5.a. and Table 6). In 2001 radial flows directed to Madrid multiplied by 2.75 times those of 1981, in 2012 radial flows continue increasing, but at a slower pace, multiplying them by 0.2-5.5 times (see Table 3).

Similarly, while radial flows to other Madrilenian municipalities were very low in 1981, in 2001 they became evident, increasing for all municipalities (see Table 6), at the time some of these other Madrilenian municipalities started to develop sub-centre roles/activities (Solís et al., 2012); the most important flows coming from municipalities near the Madrid regional boundary (see Figure 5a). Radial flows directed towards other Madrilenian municipalities increased more substantially between 1981 and 2001 than between 2001 and 2012 (see Table 3). During this last period of time, only municipalities up to 120 km from Madrid increased (significantly) their interaction with other metropolitan subcenters, while municipalities further away (with two sole exceptions within twelve municipalities at that distance) have decreased or maintained this type of relation.

In 2001 and 2012, eighteen out of the twenty surveyed municipalities have a greater relation with Madrid than with other subcenters of the Metropolitan Area, showing the hegemonic role of the national capital in attracting commuters (see Table 3). The only two municipalities with a higher interaction with adjacent metropolitan subcenters than with the metropolis are those ones close to the administrative boundary and to other Madrilenian cities (less than 15 km and more than 50,000 inhabitants).

None of the municipalities show tangential flows towards Toledo city in 1981 (see Table 6 and Figure 5.a.), possibly because Castilla-La Mancha region and its regional capital were established in 1982, while they appeared in 2001 (already regional capital), except for those municipalities for which Madrid was in between (the province of Guadalajara). In 2001 and 2012 the municipalities showing greater flows towards Toledo have been alternatively the other four provincial capitals (Ciudad Real and Albacete in 2001 and Cuenca and Guadalajara in 2012) as if the new jobs available in the regional capital required persons that lived in other provincial capitals (persons with a greater professional/training level). The new Toledo-Albacete motorway which reduces travel time from several considered municipalities of lesser size and centrality (Alcázar de San Juan, Tarancón and Villarrobledo) has certainly had an impact in these flows increase from the central Castilla-La Mancha area to Toledo.

Tangential flows to other Castilla-La Mancha provinces, excluding those directed to the city of Toledo, already exist in 1981 in a few municipalities (twelve out of twenty) although they were weak ones\(^1\), in 2001 all of them show this type of flows and in 2012 most of them have increased (fifteen out of twenty municipalities) (see Table 6).

\(^1\) Between 5 and 55 trips.
As well as with tangential flows, flows towards other Spanish regions except Madrid, were weak in 1981 although more significantly so in the more peripheral municipalities (being noteworthy the cases of municipalities at the East –Albacete province, Almansa and Cuenca, traditionally more related with Mediterranean Metropolitan Areas, and those at the west of Toledo province, Talavera de la Reina). Between 1981 and 2001 there was a general increase of this type of flows, while they reorganize between 2001 and 2012, increasing in the two capital cities more distant from Madrid (Albacete and Cuenca) and decreasing in the three other provinces (see Table 6).

Finally, primary determinant flows (Figure 5.b.) are never tangential towards Toledo, in most occasions being radial towards the Madrid municipality and getting progressively increased. The only exceptions are:

1. municipalities less than 60 km away from their provincial capital where hierarchical flows (directed toward them) are the primary ones
2. low centrality municipalities close to provincial limits and close to other provinces municipalities of greater centrality were tangential flows get stronger
3. municipalities very distant from Madrid (more than 200 km) reinforce their hierarchical flows (toward the provincial capital), don't maintain or maintain only secondary radial flows towards Madrid or maintain their primary relation with another Spanish region (one in 2001 and none in 2012).

Secondary determinant flows (Figure 5.b.) are never tangential, in most cases are hierarchical with the provincial capital or radial (Madrid), with two sole exceptions in 2012 in the centre of the region: one municipality towards Toledo and the other one towards another municipality of greater centrality of a different province. Regarding secondary radial determinant flows, those directed towards other Madrilenian subcentres take place only from municipalities close to them (one case in 1981, and increasing numbers in 2001 and 2012).

**B. Towards multidirectionality**

The question is if what happens with labour commuting flows originating in Castilla-La Mancha municipalities resembles what has been described for multicentric structures with greater horizontal/tangential and counter-radial flows in areas more integrated in metropolitan processes.
Figure 5a. - Outward labour interactions from the surveyed municipalities (1981, 2001, 2012).

Source: 1981 and 2001 Censuses (INE) and 2012 own-elaborated survey.
Figure 5.b. – Determinant labour flows from the surveyed municipalities (1981*, 2001, 2012).
Source: 1981 and 2001 Censuses (INE) and 2012 own-elaborated survey.

* Disaggregated data is only available for municipalities with more than 20,000 inhabitants in 1981
In 1981, intermunicipal outwards flows were mainly radial and intraprovincial and only in two of the twelve municipalities with flows towards other Castilla-La Mancha provinces these were outstanding (over 20%) (see Table 4).

In 2001, the image is similar to that of 1981, intraprovincial relations prevail (Susino and Feria, 2007; Albertos-Puebla et al., 2007; Salom and Casado, 2007; Cano, Ruiz and Venturada, 2010) in almost all municipalities (see Table 4). Nevertheless, radial relations are gaining importance against intraprovincial ones (thirteen municipalities are increasing their interaction with Madrilenian municipalities while decreasing those within the same province of residence). In 2012, intraprovincial flows exert as well a crucial role in commuting patterns, and the number of municipalities with an outstanding polarization in Madrid (higher than with the rest of destinations) gets smaller.

Although total intraprovincial flows are the most important ones, comparing flows towards their corresponding provincial capital city and Madrid, in 1981 and 2001 a high number of municipalities show hegemonic interactions with Madrid. In 2012 two tendencies can be observed (see Table 4): a) for those municipalities up to 200km from the metropolis, Madrid still plays a higher attraction than the provincial capital city and b) for greater distances, the situation completely inverts.

Comparing extra-provincial flows (see Table 4), in 1981 only for the closest municipalities to Madrid, they are predominantly radial, while the ones close to the external Castilla-La Mancha boundaries have a significant interaction with other Spanish regions. In 2001, the outstanding attraction of Madrilenian municipalities expanded, covering more distant municipalities and reinforcing them for the closest ones to Madrid. Only the municipalities of the Albacete province keep their higher interaction with other national territories (mainly Mediterranean Metropolitan Areas). In 2001, tangential flows start gaining importance. In 2012 radial flows towards Madrid consolidate only up to 130 km (with a few greater distances facilitated by High-speed rail), while further away tangential flows maintain an outstanding importance.

Therefore, contrary to what happens with absolute figures, more related to population sizes and centrality levels, it could be concluded that determinant interactions are more dependent on the proximity to Madrid.

To sum up, two tendencies can be observed. Firstly, between 1981 and 2001, Madrid reinforces its traditional attraction as the main destination of extraprovincial flows, both for close and peripheral municipalities. Secondly, during the last decade of the centrality of Madrid as a main destination weakens while other Castilla-La Mancha centers start acquiring greater importance, giving rise to more complex mobility patterns. Nevertheless, tangential relations are still weak and only in a reduced number of municipalities, all of them close to the center of Castilla-La Mancha, they are important (see Table 4).
4.1.2. Business relation patterns

The evolution of business travel from the Ciudad Real province municipalities between 2006 and 2012 shows a general increase and a relative increase of tangential and inter-regional ones and a relative decrease of hierarchical towards the provincial capital and of radial ones (see Figure 6). In 2006 there was a strong concentration of radial (35%) and hierarchical with its provincial capital (21%) flows, and tangential towards the regional capital were smaller (6%) and there were also a few relations with other regions (Garmendia et al., 2011). In 2012 radial and hierarchical flows are still important but relatively get reduced by half (radial to 19.0% and hierarchical to 8.4%), while tangential with the regional capital get increased by one third (to 9.4 %), surpassing the hierarchical ones, and the other tangential ones increase to become significant (to 8.4%), as well as those directed towards other regions (to 19.4%) (see Figure 6). Business purpose mobility patterns become more complex due to destination diversification.
Comparing labour commuting and business travel in 2012 in all five Castilla-La Mancha provinces, three main differences can be observed (Figure 7):

1. Business travel takes place along longer distances than labour commuting.
2. Business travel pattern is less complex than labour commuting one, since the flows emerging from are centralized in a smaller number of destinations of higher centrality levels (mainly Madrid and to a lesser degree, the capital cities).
3. Total tangential business flows (towards Toledo and other regional provinces) are clearly greater than tangential labour commuting. The number of municipalities engaged in tangential business travel doubles those engaged in tangential labour commuting.

Figure 6. - Comparative of total business travels (2006 and 2012) for Ciudad Real province. Source: authors based on Garmendia (2008) and 2012 own-elaborated survey.

1 Since business flows are less frequent than commuting ones and a lower number of workers (head of the family) travel for this purpose, in order to show accurately the real image, the thresholds to identify determinant business flows are reduced to 50 workers and 5% of the total outward flows.
4.2. EVOLUTION OF NON-WORK RELATED FLOWS

Non work-related information is tackled under two scopes. First, its 1980-2012 evolution only for the Ciudad Real province. Second, its 2012 pattern for the whole Castilla-La Mancha region, analysing not only the whole functional network but also the determinant flows. Two types of flows will be considered: shopping clothes and access to specialist health services.

Both, clothes shopping and specialist health services trips have similar functional structures (and intensities), highly centralised towards Madrid (mainly of the closest municipalities to Madrid and the provincial capital cities) and their capital cities (mainly of those municipalities further away from the metropolis). Both polarisations have been reinforced between 1980 and 2012. Regarding the relevance of the regional capital (Toledo), despite that it has been increased, none of the flows are already principal determinant ones, and only are secondary determinant ones for municipalities at the centre of Castilla-La Mancha.

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1 All considered surveys, 1980 (Pilet et al., 1980), 2006 (Garmendia, 2011) and 2012 by authors contain also three other types of travel that don’t provide significant different information and thus will not be presented here.
4.2.1. Clothes shopping patterns

Clothes shopping flows originated in Ciudad Real province municipalities (see Figure 8) in 1981 were characterized by their high centrality, hierarchical flows with the capital city. Radial flows with Madrid emerged in 2006, incorporating very few tangential ones (only from the closest municipality to Toledo). Between 2006 and 2012, radial flows have been reinforced and tangential ones start consolidating (more towards the regional capital but also towards other regional destinations) as well as other interregional flows.

The regional 2012 pattern (see Figure 9) shows on the one hand that municipalities near Madrid have greater radial flows (around 80% of total generated trips) and mainly with Madrid; nevertheless municipalities near the Madrilenian administrative boundaries have important percentages of radial flows directed toward other metropolitan centers (more than 25%)\(^2\). On the other hand, municipalities further away with low centrality levels present greater intraprovincial patterns, while those with bigger centrality levels more radial ones. These further away municipalities also show some small interregional flows.

The only substantial tangential relations (between 22.5% and 59.5%) happen from municipalities located in the centre of the region, but almost none are principal determinant flows (see Table 5). The exception is between municipalities close to provincial borders (towards provincial capitals or nearby municipalities of intermediate centrality levels of other provinces).

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1 It has already been indicated that travel to buy appliances, furniture and cars produce similar intermunicipal travel patterns as clothes. The only difference being a that out of province travel in slightly more concentrated towards Madrid and less to other provinces and regions.

2 Even doubling it -39.9%- those polarized in Madrid -16.6%- for the case of Azuqueca de Henares.
Figure 9. – Total outward linkages and synthesis of the determinant ones regarding travels for clothes shopping (2012) for the entire Castilla-La Mancha region. Source: 2012 own-elaborated survey.
4.2.2. Travel to access specialist health services

During the last two decades sanitary services have been improved under regional logics\(^1\) and have favoured mobility patterns less centralised towards Madrid and the provincial capitals (those with the greatest sanitary supply in 1980).

In contrast to clothes shopping, intermunicipal flows originated in the Ciudad Real province municipalities are already present in 1980; only radial for the closest municipalities to Madrid, and hierarchical with the provincial capital for those with low centrality levels (see Figure 10). During this year the most important flows are hierarchical followed by radial ones. In 2006 these flows were very similar, but including some intraprovincial flows towards close intermediate centrality municipalities (due to their improved health services) as well as radial ones towards Madrid and tangential towards Toledo. Nevertheless, municipalities that already had radial flows in 1980 reduce their relative importance in 2006 (possibly due to improved provincial health services). Between 2006 and 2012, the number of municipalities directing flows to Madrid increases and radial flows reinforce their relative importance as well as tangential ones towards the regional capital (it is reached by a broader territory and attracts a greater number of trips) and, to a lesser extent, towards the biggest and more distant provincial capital city (Albacete).

The regional 2012 access to specialist health services flows (see Figure 11) shows a similar pattern to that of clothes shopping. Although radial flows are still crucial (almost all the municipalities have primary or secondary determinant flows towards Madrid), intraprovincial flows are the most important ones, between 53 and 87% (see Table 5). Regarding tangential relations, they are relevant for those municipalities close to the central area of the region, between 56 and 70% (see Table 5) and none of the primary determinant ones are directed to Toledo. Only one municipality (Alcázar de San Juan) has a secondary determinant flow towards Toledo (representing 13.5% of its total intermunicipal flows). The three municipalities closest to the Mediterranean coast and more distant from Madrid show noteworthy secondary interregional determinant flows, between 18 and 35% (see Table 5).

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\(^1\) Including new hospitals at Alcázar de San Juan and Hellín in the 1990s and Almansa, Tomelloso and Villarrobledo in the 2000s.
**Fig. 11.a.** Total outward flows of high-centrality municipalities

**Fig. 11.b.** Total outward flows of medium- and low-centrality municipalities

**Fig. 11.c.** Synthesis of determinant flows of surveyed municipalities

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**Figure 11.** Total outward linkages and synthesis of the determinant ones regarding travels to specialist doctors (2012) for the entire Castilla-La Mancha region. *Source: 2012 own-elaborated survey.*
5. CONCLUSIONS

The present article adds to recent literature on metropolitan polycentric regions by analysing their more distant parts and by exploring if complex and horizontal flows described on areas up to a certain distance from metropolitan cores also take place in these more distant areas.

The article studies a Spanish region located 50 to 200 km from Madrid; an area lacking structure and internal cohesion (Prado, 1996; Cebrián, 2007; Pillet et al., 2010) where transport infrastructures pursue national criteria crossing the region rather than articulating its different parts. An area transformed into a politico-administrative region since 1982, which established a regional capital and a few regional motorways at the same time as becoming progressively articulated in the Madrid metropolitan processes. The conclusions derived from the case study are useful for other metropolitan areas in the process of becoming polycentric with their traditional metropolis still playing a major role.

These distant areas tend to increase their intermunicipal relations substantially, possibly as a consequence of being more integrated in polycentric metropolitan regions. Their intermunicipal relations also become more complex, both for labor related and non-labor relations. This growing complexity generates new relations towards outside their traditional catchment areas, different to what have been called hierarchical relations with the provincial capital; this is to say, tangential relations between similar distant areas, radial ones between distant areas and the core of metropolitan regions and interregional ones between distant areas and other regions.

However, intermunicipal relations of distant parts of metropolitan regions are still much less developed than those of closer areas; they are more in their infancy in comparison. Therefore, despite the fact that some weak horizontal relations are emerging far away from the metropolitan core, more noticeable for business flows, the redistribution of flows towards more complex patterns characterizing highly articulated metropolitan areas (for the Madrilenian case, up to 50 km away the metropolis) are not so evident for further away territories. The most important flows in these further away areas being hierarchical/radial, both towards the metropolitan core and provincial capital cities.

Nevertheless, several new spatial patterns are appearing and can be recognized in these distant parts of metropolitan regions:

1. those municipalities closer to the metropolis maintain or increase their radial flows towards it and they are the only ones to start developing flows with other important metropolitan subcentres close to the central cores (similar to what Polynet Action 1.1 concludes for Paris not too distant FURs, 40-50 km).

2. the most important relations with other metropolitan subcentres (20-30 km far from the metropolis) are for labor commuting, and much less for all other travel purposes.
3. the attraction capacity of the metropolitan core means that up a certain distance (in Madrid around 150 km) radial interactions are stronger than hierarchical to the provincial capital cities ones.

4. despite new regional capitals and transportation infrastructures are facilitating the slow appearance of new tangential relations, generating more complex mobility patterns, most of the primary determinant flows are still radial and hierarchical towards the closer traditional territorial centers. This radial importance is similar to Hall and Pain (2006) and de Goei et al., (2010) conclusions for South East and East England. The high relevance of intraprovincial flows in distant areas evidence the low development of polycentric structures at the intra-regional level, where the provincial capital still exerts an important influence and a limited number of trips, although gaining importance, take place beyond province administrative boundaries; these results are in line with the findings by de Goei et al., (2010) and Solís et al., (2012) but contrary to those of Limtanakool et al., (2009). However tangential relations to the new regional capitals are never as important as radial ones, that is to say, attraction capacities of new regional capitals do not reach that of metropolitan cores, and only for business related flows, total tangential relations equal or even exceed total radial ones. This could be also due to the ‘small’ thirty years time lapsed since new regional capitals have been established.

5. the only flows that reduce their radial and hierarchical to provincial capital cities interactions are accesses to public services (health, which in Spain is mostly supported by public hospitals and health centers) due to improved sub-regional public facilities.

6. municipalities with greater centrality capacities (size, public administration, public services, economic activities, etc.) tend to develop intermediary roles attracting a greater percentage of flows from municipalities with lower centralities and reversely their own relations take place increasingly so with the metropolises or other municipalities of their same centrality level.

Three subareas can clearly be distinguished in these distant territories of metropolitan polycentric regions (see Figure 12 for the Madrilenian case):

1. a sub-area composed of municipalities specialized in radial relations (dependent mostly on the metropolitan core) up to a certain distance of the metropolitan core; a distance which has been reduced (in terms of covered territory) during the last decade.

2. a central area which reinforces its internal relations (between themselves) and generates outstanding tangential relations (becoming as important as or even greater than radial ones) to other distant municipalities of greater centrality levels, tending to overflow the traditional supramunicipal administrative boundaries.

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1 There exists stronger interactions between urban regions of the SE and E of England towards London (what we have called ‘radial’ relationships) than within urban regions in SE and E.

2 Stronger interactions exist within urban regions in the South East and East of England than between them (de Goei et al., 2010).

3 Limtanakool et al (2009) conclude by analyzing commuting and leisure flows of 23 Daily Urban Systems in The Netherlands, the reconfiguration of the urban system towards fully polycentric ones, more clear at regional than at inter-regional level.
3. a sub-area composed of the most distant municipalities close to other Spanish regions and metropolitan areas, which presents more polarization towards the nearest provincial capital city or to other national destinations (interregional relations) rather than to the metropolis.

In relation to the specific Castilla-La Mancha case study, mobility patterns are characterized by an intermunicipal mobility increase during the last three decades, more significant between 1981 and 2001, as well as by the diversification and greater complexity of functional interactions, not only commuting flows but also other non work-related ones, despite intraprovincial and radial relationships still exert a relevant weight for all trip purposes. However, the area where radial relations represents a predominant role over the rest of tangential and interregional relations (despite a general increase of radial flows) has undergone a spatial reorganization, increasing its surface/distance from Madrid during the first two decades due to transport improvements and reducing it during the last decade because of dispersion and decentralization of activities which have allowed higher centrality levels of peripheral municipalities. On top in 2012, a new area around the regional center of gravity (approximately 150 km far away from Madrid) has appeared where tangential flows are more important than or as important as radial ones. (see Figure 12)

In relation to the research methodology the article shows the specificities of these metropolitan regions distant areas and that municipal selective surveys may be enough to understand overall regional relations patterns. Nevertheless, as results confirm that certain municipalities show different spatial relations, future surveys should pay greater attention to them. Especially to four types of municipalities: municipalities close the traditional metropolitan area, municipalities with important centrality capacities, and municipalities with low centrality roles, both, in central regional positions and more distant ones.
Table 5. – Outward flow distribution for each surveyed municipality and travel purpose, regarding their proximity to Madrid. Year: 2012. Source: INE and authors.
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APPENDIX X

Paper A.8
THE INFLUENCE OF EDUCATION ON WORK-RELATED TRAVEL IN RURAL METRO-ADJACENT REGIONS: THE CASE OF CASTILLA-LA MANCHA (SPAIN)

Abstract

This paper examines the spatial distribution of work-related relationships in recently re-organized rural metro-adjacent regions in order to understand their urban structure. Particularly, this research explores different travel purposes (commuting and business) and education levels (average working population and highly-skilled professionals) in the Castilla-La Mancha rural region (Spain). The empirical results illustrate that: a) regardless of education level, regional cohesion was greater for commuting than for business travel and openness to other Spanish regions was greater for business trips than commuting; b) for highly-skilled professionals, metropolitan integration was greater for business travel than commuting; c) for the average working population, metropolitan integration was greater for commuting than for business purposes. Nonetheless, the outstanding level of interaction within the region (for both travel purposes and the overall working population), mainly among the main regional centralities, evidences an emerging intra-regional polycentric urban system. Finally, while it is concluded that the private car has a prevailing role in modal split both for commuting and business travel, differences are recorded in terms of travel purpose and education level. In this sense, findings reveal that high-speed rail gets greater relevance among highly-skilled professionals and for business trips.

Keywords

Commuting, business travel, average working population, highly-skilled professionals, rural metro-adjacent region, modal split, Spain.
1. INTRODUCTION

Since the 1970s, metropolitan externalities are no longer concentrated in only one city but shared among several interlinked intermediary centres resulting in the traditional monocentric model evolving towards a polycentric one [1-5]. In these emerging polycentric urban models, thanks to communication and transportation improvements (such as high-capacity road and high-speed rail networks), 'temporary' movements (commuting, short-term assignments, intra-company transfers, business trips or virtual contacts) have become more common and a new kind of contemporary professional has emerged: the mobile professional [6]. However, until now many scholars have traditionally focused on migration flows (particularly of skilled people, due to their capability for strengthening a region’s economic prosperity) [7].

Apart from increasing mobility levels, these polycentric systems (both housing and labour markets) have also led to significant changes regarding the direction of flows, travel distances and times as well as modal split [8-10]. First, in percentage terms, periphery-periphery and core-periphery relationships have increased, while travel to the central metropolitan core has been reduced [11-13]. Second, European studies have concluded that population dispersion, economic decentralization and polycentric urban structures have contributed to an increase in commuting distances and car-dependency [14-17].

Much has been written about the nature of travel and the increasing functional interactions in the currently globalized economy [18-20] and several studies have already sought to disentangle the complex relationship between urban structure and mobility patterns (especially since the 1980’s, when the new polycentric urban spatial configurations started to emerge). However, largely because of the limited available data, debates generally focused on:

a) Labour commuting flows [21-22] as the major daily recurrent form of travel [23-25]. Nevertheless, apart from commuting, business mobility occupies a crucial role and constitutes a key factor in planning transport infrastructures in the globalization era. The growing number of multinationals/multiplant businesses with geographically distant units/offices, the increasing intra- and inter-firm national/international relations, the improved/faster transport systems together with relative ease of movement or the growing need to attend conferences, trade shows and courses, make that business meetings progressively represent an important type of mobility and an essential component of working days [26-29]. Thus, in-depth explorations of the spatial organization of business flows in contrast to other forms of work-related interactions are necessary. Moreover, few studies have deepened in the education and/or professional level of travellers and none of them on the impact of high-speed rail (HSR) on functional relationships. The analysis of work-related relationships of highly-skilled workers become crucial to understand to what extent a region is immersed in globalization processes, and to what extent certain transportation modes have an influence on this integration.
b) Specific geographical areas, mainly large global cities and urban regions [30-32] or international and cross border business relationships [26, 33]. However, since professional interactions are not only taking place at the international or national scales but also among an increasing number of smaller or regional firms [34], more emphasis should be placed on rural or sparsely populated territories [35-39].

Consequently, the aim of this paper is to analyse the spatial distribution of functional work-related relationships in rural regions highly influenced by metropolitan processes (what we call rural metro-adjacent regions) and (recently) re-organized by state re-scaling processes and the impact high-speed rail connections have on them. As well, this paper examines the capabilities of mobility patterns for explaining these rural regions’ urban structure. This is done by taking into account different travel purposes (called travel “multiplexity”) and socio-economic profiles (called “individual heterogeneity”) [40]. Particularly, commuting and business travel patterns are compared for average working population (hereinafter AWP) and highly-skilled professionals (hereinafter HSP). The analysis focused on central Spain, specifically on the Castilla-La Mancha region, adjacent to the Madrilenian region and towards which metropolitan processes have already begun to have a spillover effect [41, 42]. The data to support this research was provided by commuting and business travel collected from two original mobility surveys that were carried out during 2012. The first one was addressed to a sample of regional households and the second one, to three university graduate professions (Architecture, Civil Engineering and Legal professions).

This research was motivated by the following five issues:

a) the polycentric urban configurations that have emerged during the last three decades in the most highly urbanized parts of the world and that have started to absorb medium-sized cities of nearby rural territories.

b) the increasing dynamism of rural regions, some of them evolving even more energetically than large metropolises [43-47]. Two sets of processes are crucial to the increasing dynamism in these rural areas: 1) metropolitan processes, which have started overflowing beyond their traditional boundaries, thanks to improvements in transportation networks [48], and integrating new sub-centres in their catchment areas [49]; and 2) state re-scaling, that equip governments with appropriate political strategies to coordinate supra-national and intra-national scales while promoting territorial competitiveness in the current globalization era [50-51].

c) the increasing importance business meetings play in mobility patterns as an essential component of working days [26-29,52] and their changing patterns in Europe and North America identified mainly in terms of origins, destinations and duration [53-18]. Thus, while commuting has been traditionally explored as one of the major forces of change in rural areas\(^1\) [54] and as an

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1 Commuting can be an alternative to migration, giving raise to the decrease of the depopulation of the most sparsely populated areas [38]. In order to achieve this, transport and road investments are crucial to make long-distance commuting feasible or tolerable as a daily journey.

[379]
important component of daily travel [55], an in-depth exploration of other travel purposes is needed since they occupy a crucial role in mobility [56] and their spatial patterns could adopt various forms in contrast to those of commuting [57].

d) the increasing dependence of individual choice on travel behaviour. Apart from the geographical mismatch between origin (home) and destination (workplace) and built-up area characteristics (density, diversity and design) [58-61], the workers’ demographic-socioeconomic characteristics [9, 24, 62-69] have a relevant impact on mobility patterns. While greater attention has been given to gender compared to other socio-demographic variables, variations in the number of flows and the average commuting distances were shown to be greater by occupation than by gender [65]. Considerable differences in the labour-market geographical scopes regarding education levels have also been found: highly-educated workers are more willing to commute and are more likely to engage in long-distance travel [70-72].

e) the noteworthy dependence of transportation mode choice on travelling costs (in terms of time and money). Thus, unless the employer pays for the work-related trip, salary (and thus, education level and occupation) is decisive in choosing between transport modes and it should be enough to compensate for expensive travel fares (which are usually those associated with the faster transportation modes). Undoubtedly, the accessibility to train stations, bus stops or airports is also of crucial importance. Nevertheless, despite the speed and comfort advantages of airplanes, trains and express coaches (which can facilitate long-distance commutes), the car has been the fastest growing mode of transportation in the world and the most important one in explaining extended mobility [73].

The remainder of this paper is organized into the following four sections: a) the case study; b) data sources and methodological approach; c) findings comparing commuting and business travel patterns for different education levels (average and highly-skilled workers); e) summary of the paper conclusions.

2. STUDY AREA: CENTRAL SPAIN AS A CASE STUDY

The study area covers two adjacent administrative regions: Madrid and Castilla-La Mancha (CLM) (Figure 1). While previous scholars have already analysed mobility in central Spain, most of them have focused on the Madrid Administrative Region [14, 74]. Recently, studies have analysed the CLM region, some in an isolated manner [37] and others combined with the Madrid region [49].
NOTE. The numbers refer to the municipalities where the household mobility surveys were addressed (in bold, the eleven FUA centres identified by Pillet et al., 2014): (1) Guadalajara; (2) Toledo; (3) Cuenca; (4) Ciudad Real; (5) Albacete; (6) Talavera de la Reina; (7) Puertollano; (8) Sigüenza; (9) El Casar; (10) Alcaudete de Henares; (11) Illescas; (12) Torrijos; (13) Ocana; (14) Tarancón; (15) Madridejos; (16) Mota del Cuervo; (17) Motilla del Palancar; (18) Alcázar de San Juan; (19) Tomelloso; (20) Villarrobledo; (21) Valdepeñas; (22) Almansa. Conversely, the surveys addressed to the highly-skilled professionals were emailed to all the members of each professional association.

Figure 1. - The Castilla-La Mancha Administrative region as case study: main urban and transport networks.
Source: CNIG, INE; authors.
2.1. MADRID ADMINISTRATIVE REGION

Since the 1980s, transport investments have been transforming the traditional radial network toward the metropolitan centre into a radio-concentric one. In parallel, processes of population/economic decentralization have taken place, leading to the emergence of new metropolitan sub-centres and the integration of historic cities and to the expansion of the metropolitan region beyond the Madrid Administrative Region [75]. As a result, functional interrelations have developed in the neighbouring provinces of two different ‘rural metro-adjacent regions’ [49]: CLM and Castilla y León.

As a consequence of the aforementioned transport and urban networks transformations, commuting mobility patterns within the Madrid Administrative Region have changed over the last three decades¹ [76-78]:

a) The overall mobility increased from 299,668 in 1981 to 1,297,709 in 2011;

b) The comparative importance of destinations changed:
   1) centripetal flows towards the municipality of Madrid substantially declined from 65.6% in 1981 to 44.2% in 2011,
   2) centrifugal flows from the municipality of Madrid to the rest of the Madrid region increased from 14.1% in 1981 to 18.5% in 2011,
   3) tangential (or periphery-periphery) flows between metropolitan sub-centres considerably increased from 20.3% in 1981 to 37.3% in 2011.

2.2. CLM ADMINISTRATIVE REGION

CLM, located between 40 km and 300 km from the municipality of Madrid, is an ‘Objective 1 rural region’ in European policies with low demographic density (26.4 inhab/km² in 2012) that predominantly comprises municipalities of less than 2,000 inhabitants (78.8% in 2012). However, half of the population (55.6% in 2012) is concentrated in 39 municipalities with more than 10,000 inhabitants. Only seven municipalities are between 50,000 and 175,000 inhabitants: the five provincial capitals, Talavera de la Reina and Puertollano (see Figure 1).

Created in 1982 and comprising five provinces (see Figure 1) with Toledo as the new regional capital, CLM has traditionally been defined as a disorganized, acephalic/leaderless region that lacks functional cohesion and is conspicuously influenced by Madrid [79]. Nevertheless, recent studies account for an incipient CLM polycentric urban structure: i.e. [37] identified 10 Functional Urban Areas

¹ It is important to mention that while the 1981, 2001 and 2011 Spanish Censuses asked for the municipalities of residence and work, each one made this information publicly available in a different way. The 1981 and 2001 censuses provide out-commuting information for all municipalities, although 1981 data are only disaggregated towards municipalities with more than 10,000 inhabitants or provincial capital cities. In the 2011 census, as an effect of the economic crisis, data were only collected for a sample from each municipality, and out-commuting statistics, which are not available for the smallest municipalities, are only published for workplace municipal type of location and size (and not by specific flow destinations).
(FUAs), organized by 11 FUA centres (which constitute the main CLM urban structure), and another 15 areas dependent on the 10 FUAs (due to the low regional population density).

The national ‘passing-through’ character of CLM transportation infrastructures has also shaped the regional urban dynamics. Recent transportation investments have predominantly improved radial road and high-speed rail networks (connecting to the national capital), although a few tangential infrastructures have been established within the region (three tangential motorway stretches [CM-42, A-43 and A-40] and a few low-frequency regional high-speed rail connections).

Mobility patterns within the CLM Administrative Region have also changed over the last three decades [76-78]: a) an outstanding increase in out-commuting, from 9.7% in 1981 to 31.6% in 2011, greater than other rural regions less influenced by metropolitan processes; b) an increase in commuting with the Madrid administrative region, from 20.5% in 1981 to 32.3% in 2011; and c) an intensified intra-regional cohesion derived from increasing out-commuting among FUA centres, from 4.6% in 1981 to 10.0% in 2011.

3. DATA SOURCES AND METHODOLOGICAL APPROACH

3.1. SAMPLING AND DATA COLLECTION

Due to the poor quality of official commuting statistics and the lack of official CLM statistics for travel purposes other than commuting, particularly business trips, the data in which this research is supported were based on two original surveys:

a) A mailed paper-and-pencil survey of CLM households

Own-elaborated mobility questionnaires were addressed to a sample of regional households during April-May 2012. The methodology, previously shown to have revealing conclusions regarding mobility patterns [80], consisted of organizing a tree-shape distribution and collection method with a set of key individuals (direct contacts) who distributed the leaflets to the whole sample. Respondents (households) were selected from last-grade students at a set of selected high-schools (eighty-three centres distributed among twenty-two regional municipalities1 including the FUA centres identified by [37]). Despite the bias generated by only considering part of the regional population, this sector has noteworthy mobility levels [81] thus making its analysis more interesting.

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1 The twenty-two municipalities were selected by: a) their geographical location in order to characterize key regional municipalities homogeneously distributed throughout CLM; b) their population size and the presence of, at least, one high-school; c) their positive 1981-2011 demographic dynamics; d) By their intermediary role and capability for organizing/articulating adjacent territories.
A total of 25,400 leaflets were distributed to students and questionnaires were filled out at their household during April and May 2012. Although 7,332 responses were received (29% response rate), after a debugging process, 6,901 valid answers (27% response rate) comprised the final data. The sample had less than a 1.5% margin of error and a confidence level of 95%, constituting a representative sample of all regional households (785,907 in 2012). The questionnaire was organized in two sections:

a) Questions about the household and its head (place of residence, gender, age, number of children in the household, education level, occupation);

b) Questions about work-related travel (commuting and business) to other municipalities, including the transportation mode used in undertaking them.

b) An internet based survey of different types of highly-skilled professionals residing in CLM.

Since during the last two decades the number of workers independent of a formal organization has considerably increased [6], instead of focusing on specific corporations, this survey was addressed to three professional sectors (Architects - ARCH, Civil Engineers - CE, and Lawyers - LAW, residing in CLM). These professional sectors were chosen for two reasons: a) due to the already assessed outstanding intermunicipal mobility levels for ARCH and Engineers in other Spanish regions [82]; and b) in order to collect information from professionals working both for public and private sectors (CE have a traditionally strong tie with the public sector, while the other two types of professionals are usually more related with the private one).

Following a similar methodology to others used in previous studies [6, 83-85], the internet based questionnaire was emailed to all the members of the CLM Architecture, Civil Engineering and Legal Professional Associations in May 2012. Table 1 collects the number of valid responses received by the end of the month.

This questionnaire included questions about:

a) The surveyed professional gender, age, municipality of residence and company they worked for (freelance or contractual basis, public and/or private sector, size in terms of the number of offices, location of the headquarters);

b) The regular workplace municipality and the transportation mode used to access it;

c) The business travel destinations during the previous complete working week. Each relation was characterized as intra- or inter-firm, by the transportation mode used and by its frequency (annual, monthly, weekly, twice or more per week).


3.2. COLLECTED DATA PROCESSING METHODOLOGY

Due to the recent diversification and complexity of workplaces (as a consequence of, among others, the emerging polycentric urban structures and the rapid development of ICT) [85-87] this paper distinguishes between different types of mobility:

a) Commuting travel, which comprises daily travel between the place of residence and place of work. This paper considers only out-commuters (workers traveling daily for working purposes to a different municipality than that of residence);

b) Business travel, which comprises work-related trips to an irregular place of work. Business travel provides a very flexible form of corporate mobility [88]. This paper considers only business trips to a municipality other than the place of residence;

Despite the fact that in both surveys (regional households and HSP) individuals were the sample units, their work trips were the basic unit of our analysis. Consequently, in order to determine the capabilities of the main cities in the study area (FUA centres) for attracting professionals (both frequent - residence or regular workplace locations - and sporadic - as business travel locations), these work trips were classified according to their respective destinations:

a) Madrid Administrative Region, distinguishing between those directed towards the metropolitan centre (Madrid municipality) and those oriented to the remaining region;

b) CLM municipalities, distinguishing between those directed towards the main regional cities (FUA centres) and the rest of the CLM region;

c) Other Spanish regions (except Madrid) or countries.

These relations were compared between average households and overall HSP (all surveyed workers were weighted by the population of each professional association). This comparison was done by assessing: a) the total share of workers engages in out-commuting/business travel; b) the covered distances; c) the working/business destinations; and d) modal split.

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Table 1. - Response rates of the internet base survey. Source: authors.

<table>
<thead>
<tr>
<th>Professional sector</th>
<th>Members of CLM professional association (in 2012)</th>
<th>Responses received (percentage of response rate)</th>
<th>Valid responses received (percentage of response rate)</th>
<th>Error of the sample</th>
<th>Confidence level of the sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total CLM HSP¹</td>
<td>7,172</td>
<td>479 (6.7%)</td>
<td>417 (5.8%)</td>
<td>5 %</td>
<td>95 %</td>
</tr>
</tbody>
</table>

¹ The margin of error and level of confidence were, in each individual case (for each of the three surveyed professional sectors), lower than 10% and 95% respectively.

² While euclidian distance has been widely used in travel behaviour analyses they are shorter than network ones. Since in Spain car-dependency has considerably increased as a result of population dispersion, economic decentralization and emerging polycentric urban structures [14] and in 2011 more than 70% of the commute trips were done by car [78], travel distances along the road network were assessed in this study.
4. FINDINGS: A COMPARISON OF THE CLM RURAL METRO-ADJACENT REGION HOUSEHOLDS AND HIGHLY-SKILLED PROFESSIONALS

4.1. RESIDENTIAL CONCENTRATION

Significant patterns of residence concentrations were found with regard to education levels, being the share of HSP residing in the eleven CLM FUA centres (73%) higher than the one of the average regional working population (54%).

Thus, in accordance with existing literature [11, 89], differences in residence location were also found in rural metro-adjacent regions when considering education levels: greater proportions of university-educated workers’ residences were concentrated in the main (central) cities. As some scholars have already pointed out, despite the possibility of decentralization offered by new technologies (in the case of CLM, the improved road network and the four HSR lines connecting with Madrid), this concentration of HSP in main cities (business centres) could be justified by the key importance given by these talented professionals to urban amenities and quality life or by the need for F2F contact [90-92].

This relevant concentration of residential locations in FUA centres (either of the average regional household or of HSP) points to the consolidation of the CLM main urban structure as a set of centralities distributed across the territory.

4.2. LABOUR COMMUTING PATTERNS

The scarce literature on rural or low-density areas has already concluded that mobility levels are greater than those of urban regions and long-distance commuting has been associated with living and working in these areas. Besides, previous scholars have already found that having access to fast and comfortable transport modes can facilitate commuting longer distances [93]. However, travelling costs (both time and money) are one of the most important factors in explaining the choice of transportation mode. Consequently, sensitivity to distance in general decreases as education level increases. Nevertheless, the extent to which HSP residing in rural regions are as well much more willing to travel further for work-related purposes is still a remaining question.

Collected data for CLM showed that, contrary to what it could be expected and to previous literature for urban regions, a lower percentage of HSP than average ones commuted daily to a different municipality (i.e. while 17.4% of university-educated professionals were out-commuters, this was 26.0% for the AWP). This outcome, together with the noteworthy residential concentration of university-educated workers, indicates that large numbers of high-skilled jobs must be concentrated in these main CLM centralities.
Regarding travelled distances, despite the important residential concentration in the main CLM urban centres, its low demographic density (the lowest for all Spanish regions) resulted, in average, in long-distance\(^1\) commuting for the AWP (51.7 km) and more so for HSP (75.1 km) (see Table 2).

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>Distance (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLM average working pop.</td>
<td>51.7</td>
</tr>
<tr>
<td>Highly-skilled prof. (residing in CLM)</td>
<td>75.1</td>
</tr>
</tbody>
</table>

Table 2. - Average commuting distance of CLM average working population and highly-skilled professionals. Source: 2012 authors' surveys and GoogleMaps.

Nevertheless, while on average, commutes could be characterized as long-distance trips, Figure 2 clearly depicts that important proportions of commutes were short-distance: 63.5% of AWP and 68.0% of HSP commuted distances under the 50km threshold.

Apart from the influence of education on travel distances, attraction capabilities should also be explored to grasp the complexity of CLM urban network and its regional openness to Madrid and other Spanish regions.

Figure 2. - Average working population's and highly-skilled professionals' commuting distances, cumulative distribution. Source: 2012 authors' surveys.

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\(^1\) Long-distance trips have been defined in literature, although without any consensus on the threshold used. Recently, [95] chose 50 km for the characterization of trips in regards to the travel distance. In Spain, according to the MOVILIA 2006/2007 survey 64% of work-related travel covered distances less than 50 km and only 13% are trips longer than 100 km. Thus, in this study long-distance trips are defined as those greater than 50km (one-way).
As Figure 3 illustrates, a significant proportion of commuting took place within CLM itself (more than 60%) regardless of education level. Nevertheless, higher rates of commuting within the regional territory were found among university graduates (84.3%) than among the AWP (65.4%), which significantly interacted with the Madrid region (31.2%). Differences were also found regarding the capabilities of the main urban centres for attracting commuting flows. On the one hand, noteworthy concentrations of high-skilled jobs at FUA centres may explain the outstanding percentage of university-educated professionals (50.9%) commuting towards them compared to the AWP (24.8%). On the other hand, the national capital (Madrid) exerted a greater influence on the AWP (22.6%, similar to the FUA centres), than on qualified professionals (10.4%). Consequently, the attraction capabilities of FUA centres in comparison to those of the metropolitan centre were more noticeable with increasing education.

In conclusion, compared to the AWP, regional HSP were less influenced by Madrid municipality and had greater relations with CLM FUA centres. Thus, considering the total share of commutes attracted by the main centres of the CLM urban network, it could be concluded that intra-regional commuting polycentricity is positively correlated with education.

Finally, in regards to modal split, literature gathers a wide range of factors (from individual to urban structure characteristics) which influence it. There seems to be a positive link between income and car use, although the link between income and other modes (such as public transport) differs among studies [94]. Regarding population density, scholars have concluded its importance for the viability of public transport [96-98] and in workers’ mode choice for work-related trips [99]: [100] found a negative association between higher population density and commuting by car and [101] found a positive association between population density and commuting by public transport.

According to the authors’ surveys, regardless education level, an outstanding percentage (more than 80%) of commuting trips were done by private car (see Table 3). The low share of the other
transportation modes could be justified first, because of the poor quality/low frequencies of intercity bus and conventional train services/timetables in the region (which have been decreased during the last years) and second, because average commuting distances [(102) and Table 3]. Nevertheless, differences were observed in public transport shares in regards to education: while AWP used intercity buses or conventional trains (6.4%) more than HSRs (2.1%) for commuting purposes, the opposite took place by HSP (1.2% and 4.7%, respectively). It is important to notice that an important number of HSP recorded the use of different\(^1\) transport modes for commuting (mainly car and HSR). Thus, although it is difficult to assign them to only one transportation mode, this means that the use of HSR for commuting purposes maybe greater than the registered in Table 3. In any case, the mobility surveys revealed that the higher the education level, the higher the use of HSR.

<table>
<thead>
<tr>
<th>Transportation mode</th>
<th>Car</th>
<th>Intercity bus/ conventional train</th>
<th>High-speed rail</th>
<th>Airplane</th>
<th>Other/ various</th>
</tr>
</thead>
<tbody>
<tr>
<td>CLM average working pop.</td>
<td>90.5</td>
<td>6.4</td>
<td>2.1</td>
<td>0.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Highly-skilled prof. (residing in CLM)</td>
<td>88.3</td>
<td>1.2</td>
<td>4.7</td>
<td>0.0</td>
<td>5.8</td>
</tr>
</tbody>
</table>

**Table 3.** - Modal split for commuting journeys. *Source: authors’ 2012 surveys.*

To sum up, the following can be concluded regarding commuting flows:

a) an important regional cohesion (more than interactions towards other territories including the metropolitan region) which is especially significant for university graduates. In this regional cohesion, the role FUA centres play is notorious, with a more noticeable intra-regional polycentrism for university graduates than for the AWP. Partly because of the CLM HSR network configuration, which facilitates radial flows to/from the national capital and has very few services between regional territories (such as the provincial capital cities) and partly because the HSR is still very recent (built between 1992 and 2010), the high-capacity road network has played an hegemonic role in this regional cohesion (which is reflected in the prevailing use of private car in commuting in contrast to HSR).

b) a considerable integration in the metropolitan processes, but to a greater extent for the CLM AWP. This could mean that while average regional workers employed in the Madrid region decide to locate/maintain their residences in CLM taking advantage of lower land/housing prices, as education level (and consequently, salary) increases, those HSP working in Madrid decide to locate/relocate within the metro region and only those ones that work in CLM reside there. A supra-regional scale monocentric spatial structure of commuting is observed regardless of education

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\(^1\) This refers not to the different modes of transport used in the same trip (for instance in most cases, public transport travel require another transportation mode to get to and from the station) but to different choices during the week.
levels: the attraction of Madrid municipality represent more than 70% of the overall commuting flows from the Madrid region. Nevertheless, it is important to bear in mind that FUA centres consist of a total of eleven municipalities, when comparing their attraction role with that of Madrid municipality. In this noteworthy metropolitan integration, the radial character of the CLM transport system (connecting with Madrid) has played a significant role. In this case, the impact of HSR is more relevant since all the connections where built to connect with the national capital and since almost all commuting trips made by HSR where directed towards Madrid (according to the author’s surveys).

c) a low regional openness towards other national international regions.

4.3. BUSINESS TRAVEL PATTERNS

The third step of this paper compares business travel of average regional households with those of HSP in an attempt to understand whether spatial organizations of commuting and business travel are different and consequently the regional urban network has different attraction roles with regard to the type of functional linkage and education level.

As expected, being involved in business travel is positively correlated with level of education: while the percentage of AWP undertaking business trips was only 4.0%, this figure rose up to 81.2% for HSP.

In regards to travelled distances and conversely to commuting, business travel take place over longer distances (see Table 4), although in this case they were not significantly affected by education level (being approximately 120 km). This means that differences between both types of work-related travel are greater for lower education levels: i.e., whereas for AWP average business travel distance was approximately 2.5 times that of commuting, for HSP, it was approximately 1.6 times.

<table>
<thead>
<tr>
<th>Distance (km)</th>
<th>CLM average working pop.</th>
<th>126.8</th>
<th>79</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly-skilled prof. (residing in CLM)</td>
<td>120.8</td>
<td>72</td>
<td></td>
</tr>
</tbody>
</table>

Table 4. - Average business distance of CLM average working population and highly-skilled professionals. Source: 2012 authors’ surveys and GoogleMaps.

Thus, business travel could be characterized as long-distance (as Figure 4 also depicts): only 31.8% of AWP and 28.0% of HSP travelled business distances under the 50km threshold. Nonetheless, in both cases, only more than 10% of business trips were over 200 km. As concluded from the average business
distance comparison, the cumulative distribution of business distances illustrates a similar behaviour for the AWP and HSP.

![Figure 4](image)

**Figure 4.** Average working population’s and highly-skilled professionals’ business travel distances, cumulative distribution. *Source: 2012 authors’ surveys.*

Similarly to commuting, a significant proportion of business travel took place within CLM and was positively influenced by education level (Figure 5): higher rates of business trips within the regional territory were found among university graduates (66.8%) rather than among the AWP (56.4%). Differences were also found regarding the capabilities of the main CLM urban centres for attracting commuting flows: relevant concentrations of specialized services/activities at FUA centres may explain the outstanding percentage of university-educated professionals (41.1%) traveling for business purposes towards them compared to the AWP (29.2%). Thus, for an intra-regional scale, this greater attraction of FUA centres would mean a more polycentric spatial organization of qualified workers’ business travel. Interactions with both the Madrid region and the metropolitan centre were similar, regardless of education (see Figure 6). Not surprisingly in both cases, almost all business trips directed to that region were attracted by the metropolitan centre (approximately 90%). This could mean a monocentric supra-regional spatial organization of business travel where the traditional centre exerts a key role. Differences between the attractor roles of Madrid municipality and CLM FUA centres were greater with increasing education level: 22.1% and 29.2%, respectively for AWP and 24.1% and 41.1% respectively for HSP. Finally, there was a greater engagement with other Spanish regions or countries for the AWP (17.9%) than for qualified workers (6.8%).
Finally, in regards to modal split, private car was concluded to be the main mode of transportation for commuting regardless education level (see section 3.3.4). Some scholars have already pointed out that having access to fast, flexible, comfortable and affordable transport modes can facilitate commuting longer distances [93]. Hence, does the greater distances covered for business purposes have an implication on transportation mode choice? That is to say, is the car also prevailing for business travel or conversely, since further territories need to be reached, public transport start exerting a more relevant role?

According to the authors’ surveys, regardless education level and similarly to commuting travel, an outstanding percentage (more than 80%) of business trips was done by private car (see Table 5). Nevertheless, for HSP, public transport modes, in particular HSR, acquires greater relevance for this travel purpose. This is in relation with distance covered for business meeting in parallel to higher incomes which allow professionals to have access to faster transport modes.

<table>
<thead>
<tr>
<th>Transportation mode</th>
<th>AWP</th>
<th>HSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Car</td>
<td>90.8</td>
<td>85.6</td>
</tr>
<tr>
<td>Intercity bus/conventional train</td>
<td>2.7</td>
<td>1.9</td>
</tr>
<tr>
<td>High-speed rail</td>
<td>5.2</td>
<td>8.1</td>
</tr>
<tr>
<td>Airplane</td>
<td>0.1</td>
<td>0.5</td>
</tr>
<tr>
<td>Other/various</td>
<td>1.2</td>
<td>3.9</td>
</tr>
</tbody>
</table>

Table 5. - Modal split for commuting journeys. Source: authors' 2012 surveys.

To sum up, the following can be concluded in regards to business flows:

a) a significant proportion of business travel took place within CLM, and was positively influenced by education level. In this relevant regional cohesion, the attractor role FUA centres played was noteworthy and greater for HSP than for the average regional working population. It is remarkable that this role of FUA centres was greater than that exerted by the municipality of
Madrid and is more noticeable for highly-skilled than for the regional population. This two facts show an intra-regional polycentric spatial structure of business flows and consequently the consolidation of FUA centres as business destinations.

b) an outstanding monocentric integration in the metropolitan processes, where most of the trips directed to the Madrid region were attracted by the metropolitan centre (approximately 90%) regardless education levels.

c) a lower regional openness towards other national or international regions, more significant for the AWP than for university graduates.

5. CONCLUSIONS

While much has been written regarding commuting or business meetings/travel, two main gaps are found in the existing literature. First, most studies analysed commuting independent of business travel behaviour. Second, they mainly focused on large global cities, urban regions and international relations paying little attention to rural or sparsely populated areas. In an attempt to fill these gaps, the aim of this paper is to analyse commuting and business travel spatial organizations for workers residing within a low-density region influenced by metropolitan processes, paying special attention to differences in workers’ education level and economic sector. These analyses are of relevant importance due to the recent increasing dynamism of these rural regions, which is partly influenced by the funds received from the European Union in order to promote their development and structural adjustment (i.e. improving their transport systems).

The first general (and predictable) conclusion extracted from the analyses is the outstanding residential concentration in the main (central) cities with increasing education levels.

Not surprisingly, education level impacts on commuting travel behaviour. However, contrary to what it could be expected, in rural metro-adjacent regions, a lower percentage of HSP commute daily to a different municipality than the AWP. This lower out-commuting for HSP together with their significant concentration in central cities would show: on the one hand, that large proportions of high-skilled jobs must be concentrated in these cities; and on the other, that these HSP’s preferences for residential location in rural metro-adjacent regions are strongly dependent on the features of the city/neighbourhood, the amenities provided and that pollution, noise, congestion or land price issues were less relevant for these professionals. In contrast, engagement in business travel is positively correlated with education level (i.e. for CLM, the percentage of HSP undertaking business trips was twenty times larger than the one of the regional working population). Moreover, the share of HSP traveling for business purposes is much greater than for commuting, and the opposite occurs for the
average population. However, distances covered for business purposes are not significantly affected by education level.

But while fewer HSP travel daily from home to work compared to the regional working population, on average they are more willing to commute longer distances. Nevertheless, noteworthy proportions of commutes take place over short-distances regardless of education. Comparatively, business travel take place over longer distances than commuting for all workers residing in rural metro-adjacent regions (being HSP more willing to undertake longer business trips). This is in accordance with [57] who found a much more local geographical scope of commuting than business travel. These longer distances covered for business trips derives in a greater use of HSR for this travel purpose (although private car has been concluded to be the main mode of transportation for commuting and business regardless education level), which is more outstanding as education level increases (as a consequence of their higher incomes).

To summarize, the comparison between CLM commuting and business travel patterns reveals that regardless of education level, regional cohesion is greater for commuting than for business travel and openness to other Spanish regions (different to the Madrilenian one) is greater for business trips than commuting. For both travel purposes, the consolidation of an intra-regional polycentric urban structure (comprised by a set of main centralities which organize the regional territory) is more noticeable for HSP than for AWP. Besides, in regards to metropolitan integration, for HSP, it is greater for business travel than commuting while for the AWP it is greater for commuting than for business purposes. Finally, while it has been concluded that the private car has a prevailing role in modal split both for commuting and business travel, differences have been recorded in terms of travel purpose and education level: HSR gets greater relevance among HSP and for business trips.
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CHANGING ACCESSIBILITY AND MOBILITY PATTERNS IN RECONFIGURED RURAL METRO-ADJACENT REGIONS


