



OECD Regional Development Working Papers 2014/01

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in the OECD: Country,
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<https://dx.doi.org/10.1787/5jz5mpdkmvr-en>

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ASSESSING POLYCENTRIC URBAN SYSTEMS IN THE OECD: COUNTRY, REGIONAL AND METROPOLITAN PERSPECTIVES

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Abstract

Contemporary urban systems in OECD countries are structured around functional regions, which often overcome established city boundaries. Reading space in terms of functional regions allows assessing changes in urban hierarchies and spatial structures, including the polycentricity of urban systems at national, regional and metropolitan scale. By using a harmonised definition of functional urban areas in OECD countries, this paper first provides a sound definition of polycentricity at each spatial scale, highlighting for each of them the different links with policy. Second, it provides measures of polycentricity and explores the economic implications of different spatial structures. Results show that relatively more monocentric regions have higher GDP per capita than their more polycentric counterparts. At country level, on the other hand, polycentricity is associated with higher GDP per capita.

JEL classification: R11, R12, R14, R58

Key-words: Spatial structure, polycentricity, urban system

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1. Introduction

The way people and economic activities organise in space have been changing over time. Improvements in communication technologies, large and growing movements of people and goods, and economic development processes have generated an enlargement of the spaces where people live and work. These changes facilitated suburbanisation processes and an increasing integration of cities with their surrounding hinterland. The emerging spaces where people live and work and where the bulk of economic interdependencies takes place is referred to in the literature as ‘functional regions’. Among functional regions, the ‘functional urban areas’ (FUAs) are characterised by the presence of one or more urban centres, of different sizes and economic importance.

A better knowledge of urban spatial organisation can have important values on regional policy making. Half of OECD population live in the 275 large FUAs (metropolitan areas) that contribute to more than 50% of GDP and employment of the entire OECD. While the concentration of people in dense urban centres of “established” OECD cities has slowed down or even decreased in some cases, the coming together of people and business in urban areas of varying sizes have not stopped. Moreover, the reduction of transport and communication costs will continue to make urban centres increasingly interconnected and change urban areas from monocentric agglomerations to a more *polycentric* system of integrated urban centres and sub-centres. The way people in cities have access to education and jobs, decent housing, efficient transportation, safe and sustainable environment will have a strong impact on national and global prosperity and thus a better understanding of the different urbanisation forms will help recognise the impact of different national and local strategies.

Polycentric agglomerations can be investigated at higher territorial scales beyond metropolitan areas. For example, in many regions a number of cities and towns are increasingly linking up and, similarly, OECD countries differ in the spatial organisation and connections among urban areas. Understanding the functioning and efficiency of these connections can help clarify the links between urbanisation and economic development. Metropolitan areas tend to be more productive than other regions, and on average the GDP per capita in OECD metropolitan areas was 15% higher than in the rest of the economy in 2010 (OECD, 2013a).

Previous works have investigated the role of polycentricity in modern urban systems both for specific countries and comparatively for European countries (Vandermotten et al., 2007; Espon, 2003). The policy relevance of understanding the links between the spatial organisation of urban areas and the socio-economic conditions of a country or a region is apparent: both for national and local policy makers, it can help targeting policies, planning public services and designing the institutional organisation and governance mechanisms that can best support the development of different territories and contribute to national growth. However, the empirical evidence on the links between polycentricity and economic development is not conclusive and results seem to depend on the choice of countries, on the conceptual definition of polycentricity and on the indicators chosen to measure this characteristic of spatial structure.

This paper investigates the economic implications of concentration of activities in space. This question is addressed here through two main contributions. First, the paper assesses the polycentric structure of OECD urban systems at three different geographic scales: in a metropolitan area, in a region and in a country. It does so by relying on a common definition of functional urban areas applied to 29 OECD countries (OECD, 2012a). Secondly, the paper explores the implication of polycentricity at national and regional level on the overall level of economic prosperity. The results show that at regional level, relatively more monocentric regions have higher GDP per capita than their more polycentric counterparts. However, preliminary investigations at the country level show that OECD countries with a more polycentric urban structure are associated with higher GDP per capita.

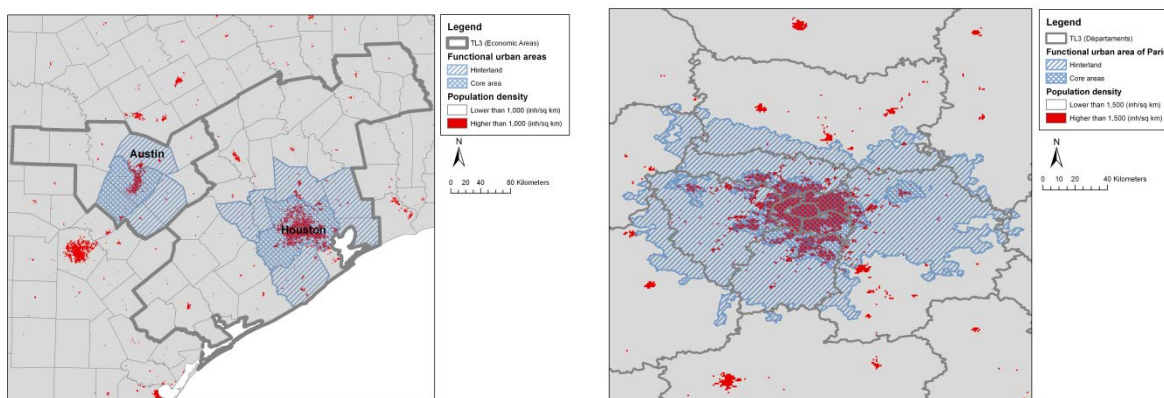
The paper is organised as follows. Section 2 briefly recalls the method to define OECD functional urban areas. Then, it articulates the concept of polycentricity at three different scales: in a metropolitan area, as a network of urban areas in a larger region, and as the urban system of a country. Section 3 provides some evidence on the spatial organisation of the OECD metropolitan areas and recent changes towards sprawl or instead more compact development. Sections 4 and 5 apply the definition of polycentricity at regional and country levels, respectively. In both cases a preliminary analysis of the links between polycentricity and levels of GDP per capita is carried out. Possible improvements of these results, including building internationally comparable measures of polycentricity based on the functions carried out by cities, are discussed in Section 6, which concludes.

2. Polycentric development and functional urban areas

Overview of the methodology to identify functional urban areas in OECD countries

The method to identify functional urban areas within OECD countries integrates geographic information sources (GIS) with administrative and survey sources to capture the highly densely populated areas (urban cores) and the commuting flows towards the urban cores regardless of the administrative boundaries (Figure 1).

Figure 1. Urban and non-urban population density; functional and administrative boundaries: Houston and Paris



Source: OECD calculations based on population density disaggregated with Corine Land Cover, Joint Research Centre for the European Environmental Agency.

The method consists of three main steps: the first step identifies contiguous or highly interconnected densely inhabited urban cores, by using population grid data at 1 km². The second step of the procedure allows the identification of urban cores that are not contiguous but belong to the same FUA. Two urban cores are considered integrated, and thus part of the same polycentric metropolitan area, if more than 15% of the working population of any of the cores commutes to work in the other core. The third step defines the commuting shed or hinterland of the functional urban area, by selecting those municipalities that send at least 15% of their work force to the cores. More details can be found in OECD (2012a).

Defining polycentricity

The first necessary step of this analysis is a clear definition of the concept of polycentricity. Starting with the most general meaning, any given area can be defined polycentric if it contains two or more centres. With just a bit more precision, an area is polycentric if its population or employment is not concentrated to a substantial extent in one single centre (Riguelle et al., 2007: 195). Considering

the distribution of population and employment in space means to interpret polycentricity as a “morphological” concept. It should be pointed out that the literature distinguishes between a morphological dimension – which focuses on population, employment, land use, etc. – and a more “functional” one (Burger and Meijers, 2012; Nordregio, 2005; Veneri, 2013a) – linked to the functions carried out by cities or the connections among them (e.g. commuting flows). However, the two dimensions are very much related to one another. The morphological dimension of polycentricity focuses on the size and distribution of urban centres across space. This dimension is often associated with the extent to which territory is characterized by a balanced development. The functional dimension of polycentricity focuses less on the internal characteristics of the centres – such as size, density, etc. – and more on the way these centres organize the rest of the territory by supplying the functions that shape the territorial hierarchies (Green, 2007; De Goei et al., 2010).

Whether a functional or a morphological approach to polycentricity is adopted can also depend on the territorial level at which this concept is applied. For the sake of simplicity, Espon 3.1 (2003) classified the territorial scales in three categories, namely “micro”, “meso” and “macro” ones. Departing from the Espon classification, this paper considers three major perspectives with which to look at polycentricity, namely the metropolitan, the regional and the national perspective. Adopting the former scale implies to consider the spatial organisation within the metropolitan space, which is a space characterised by one single – or multiple overlapping – labour market areas. On the other hand, the national perspective looks at the spatial structure of the entire national urban system or, in the case of the European space, supra-national urban system. Finally, the regional perspective refers to networks of two or more functional urban areas which are connected through functional relationships and lie in the same larger administrative region. This intermediate perspective draws on concepts that have been widely analysed in the literature, such as the Polycentric Urban Region (PUR) (Dieleman and Faludi, 1998; Kloosterman and Musterd, 2001; Parr, 2004). Different spatial scales are associated with different meanings and potential policy issues at stake. For urban systems at each scale, metropolitan, regional and national, the polycentric spatial structure is interpreted and analysed through the lens of the functional urban areas, as identified by the OECD. Table 1 proposes a summary.

Table 1. Polycentricity at three spatial scales: a summary

Geographical scale	Policy objectives	Measures
Intra-metropolitan	Improve efficiency in land use Deal with environmental challenges (e.g. air quality, landscape, ecosystem) Improve efficiency of transport and other public services	Sprawl index Share of people and jobs in urban centres
Regional (inter-metropolitan)	Exploit regional agglomeration and network economies Tackle intra-regional disparities in access to services and amenities	Relative importance of the largest city Size distribution of cities Connectivity among cities
National	Design national urban policy to focus on the potential of all cities, fostering agglomeration economies and ensuring policy coherence Tackle territorial disparities (income, services, consumption).	Relative importance of the largest city Size distribution of cities

3. Metropolitan scale

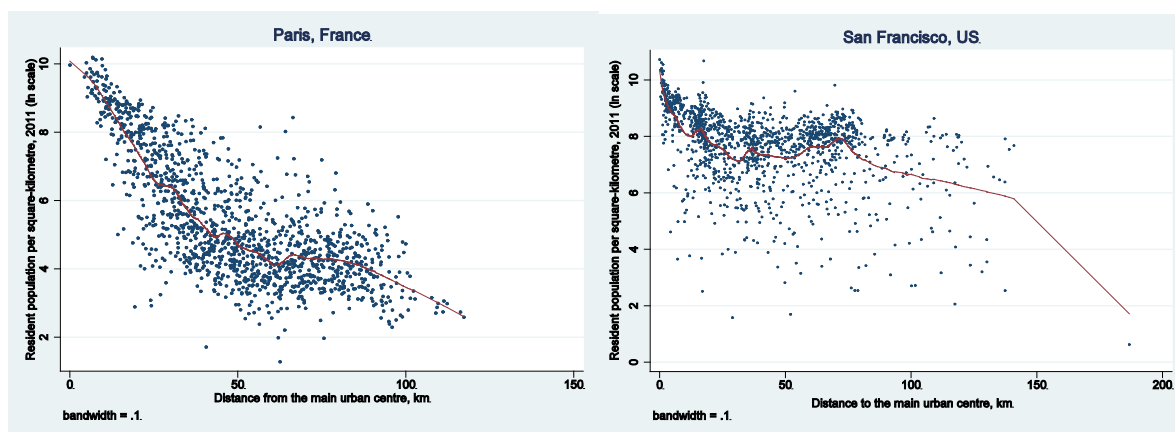
Spatial structure at the metropolitan scale has a multi-dimensional policy relevance. The way population and economic activities distribute across the metropolitan space can affect the economic performance of metropolitan areas, through shaping the intensity of agglomeration economies (García-López and Muñiz, 2013). In addition, spatial structure can be important for efficiency in the provision of public services. Public transport can be more efficiently organised when people and jobs are concentrated in centres of a certain size, which ensure the achievement of economies of scale. Other issues regard energy consumption, green space and land use. Regarding transport, for example, the degree of metropolitan polycentricity has been found to be associated with higher car dependency (Glaeser and Kahn, 2004), but evidence on the possible effect on travel time and distance is still ambiguous (Schwanen et al., 2004; Veneri, 2010; Modarres, 2011).

Assessing polycentricity at the metropolitan scale means to put the focus on a self-organised and economically integrated space, often characterised by a single labour market area or several overlapping ones. At this scale, spatial structure has been traditionally conceptualised in urban economics as monocentric, with a central business district (CBD) located at the centre of the area (Alonso, 1964; Muth, 1969; Mills, 1972). The CBD is characterised by the highest job density, which declines monotonically as the distance from the CBD increases. However, metropolitan areas have been expanding in the last decades and their spheres of influence have regionalised. Their extension goes often well beyond traditional administrative boundaries and, as a consequence, other new or pre-existing centres coalesce or integrate in the larger “functional region” (Champion, 2001) or emerge from a decentralisation process from the CBD (Anas et al., 1998). These processes challenged traditional monocentric models in urban economics and stimulated the introduction of new models, which incorporate the possibility of polycentric and dispersed structures (Anas et al. 1998; White, 1999).

Figure 2 shows the density patterns of population in the metropolitan areas of Paris and San Francisco. The figure shows that despite density decreases, on average, as distance to the main centre increases, this pattern is not monotonic and there are several local peaks of high density. This should indicate the presence of metropolitan sub-centres, hence a polycentric spatial structure. Under this perspective, one simple way to measure the degree of metropolitan polycentricity consists in identifying those spatial units that can be considered as sub-centres and computing their share of population (or employment) over total metropolitan population (or employment).

Figure 2. Density patterns in the FUAs of Paris (France) and San Francisco (US)

Density does not decrease monotonically as distance to the main centre increases



Note: Units of analysis are municipalities in the case of Paris and Census tracts for San Francisco.

Source: Authors' elaboration on National Census data.

Metropolitan polycentricity can also be seen from a different angle, by focusing on morphological features and land development patterns. Under this perspective, metropolitan polycentricity can be seen as a model of urban development that is alternative to dispersion and that is sometimes called “decentralised concentration” (Frey, 1999). In principle, it combines the need to accommodate urbanisation with that of limiting generalised dispersion of activities across space, which is often referred to as sprawl or ‘Edgeless’ city (Lang, 2003; OECD, 2012b). Using the OECD definition of FUAs it is possible to look at the dynamics of land use and to assess whether metropolitan areas are following patterns of development towards sprawl or compactness. According to Brueckner (2001), sprawl is defined here as the “excessive” urbanisation. A simple sprawl index (*SI*) has been developed to measure the growth in built-up area adjusted for the growth in city population (OECD 2013a). When the population is stable, the *SI* corresponds to the growth of the built-up area. When the city population changes, the index measures the increase in the built-up area relative to a benchmark where the built-up area would have increased in line with population growth. The index is calculated as in the formula below [1]:

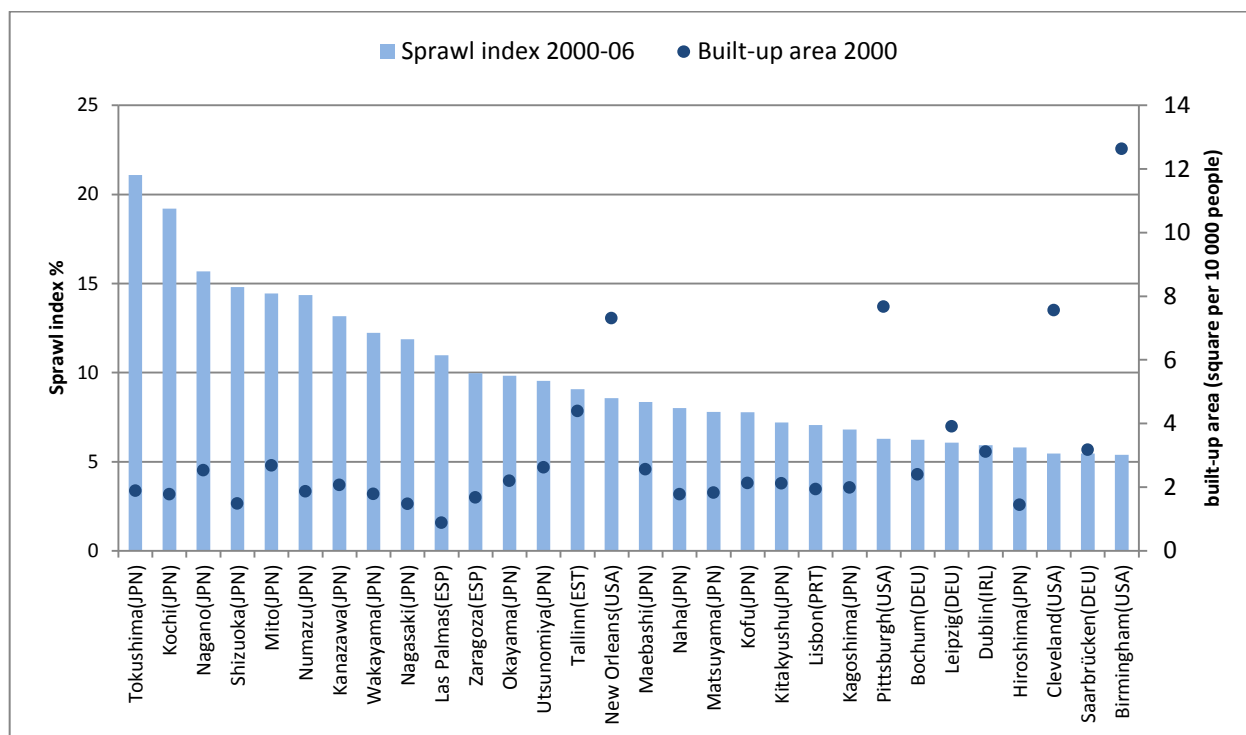
$$SI_i = \frac{\left[urb_{i,t+n} - \left(urb_{i,t} * \left(\frac{pop_{i,t+n}}{pop_{i,t}}\right)\right)\right]}{urb_{i,t}} * 100 \quad [1]$$

where *i* refers to the *i*-th metropolitan area; *t* refers to the initial year; *t+n* is to the final year; *urb* is to the number of square kilometres of the total built-up area; *pop* is total population.

The sprawl index shows a high degree of heterogeneity between the patterns of urban development within metropolitan areas in Europe, Japan and the United States.¹ There is not an overall sprawling pattern emerging. Between 2000 and 2006 one-third of the metropolitan areas experienced positive variation in the sprawl index (with the average value for the OECD being 0.8%), hence the growth of built-up land was faster than the growth of population. In other words the built-up area per person has increased. Figure 3 shows some of the metropolitan areas with the highest values of the sprawl index. Several metropolitan areas of Japan, Las Palmas and Zaragoza (Spain) and Tallin (Estonia) show values higher than 10%. However, they had relatively lower levels of built-up area per person in 2000, compared to metropolitan areas in the United States.

1. The sprawl index could not be computed in Canada, Chile, Korea and Mexico due to the absence of the land use layer in two points in time for these countries.

Figure 3. Top 30 OECD metropolitan areas for urban sprawl, 2000-2006



Source: Own calculations from *OECD Metropolitan Database*. Only Europe, Japan and United States are included.

The patterns of spatial structure within metropolitan areas can have different implications in economic, environmental and social terms. While this section will not explore empirically any of these relationships, it is enough to say that much work has been produced on the costs of sprawl, despite there is not agreement on the actual rationality of policies aimed at containing this phenomenon. On policentricity, on the other hand, much less work has been done to understand whether this pattern of spatial development might improve the efficiency in land use or the environmental conditions if compared to sprawl.

4. Network of cities: polycentricity at regional level

New concepts have been introduced in the last two decades to identify and describe regional spatial structures where several urban areas co-exist and might be able to generate positive externalities beyond the boundaries of the urban areas. Among these concepts, Dieleman and Faludi (1998) refer to 'Polynucleated Urban Field', while Parr uses the expression 'Polycentric Urban Region' (PUR) (Parr, 2004). Following Parr, PURs are regions – which can be both administratively defined or approached functionally – that are organized around several urban areas. These areas should be morphologically separated but still in close physical proximity and, in order to develop synergy, they should be functionally connected and/or have complementary sectoral specialisations (Parr, 2004, p. 232). A PUR is hence characterised by a substantial equilibrium – or low hierarchy – among cities in terms of population and economic power (Bailey and Turok, 2001) and from a clear physical separation between its centres.

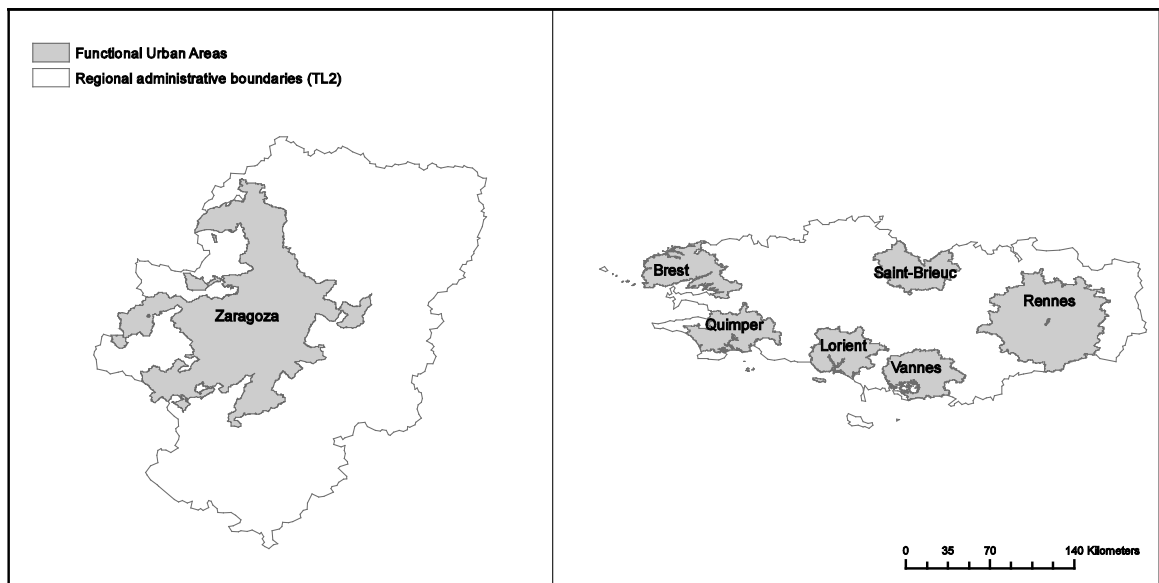
The characteristics of regional spatial structures can have different implications in terms of economic outcomes through, for example, agglomeration economies (Duranton and Puga, 2004;

Rosenthal and Strange, 2004; Combes et al., 2012; OECD, 2014) or consumption benefits, ensured by a higher variety of consumption possibilities in large agglomerations (Glaeser et al., 2001). These advantages can be reached in large cities with high population and job density. However, it has also been argued that the advantages of agglomeration can be “regionalised”, and achieved in regions characterised by the presence of several interconnected urban centres. This hypothesis was first advanced by Alonso (1973) through the idea that polycentric regions can exploit synergies emerging from co-operation and complementarities among centres, as if each centre would “borrow” its size to the rest of the region, compensating from an eventual lack of large agglomerations.

The potential economic implications of polycentric spatial structures include, in addition to the economies of scale (borrowing size), also other aspects linked to the complexity and diversity of functions. In the words of Parr (2002), these advantages should be named ‘regional externalities’, considered less strict in terms of spatial agglomeration of individuals and organizations than agglomeration and localisation externalities. Regional externalities can emerge especially in the context of regions characterised by city-network relationships, providing benefits such as sharing high-scale infrastructures, highly qualified specialized services (Priemus, 1994) or exploiting regional complementarities that might emerge from local endowments of hard and soft factors of development.

Using the OECD definition of FUAs, it is possible to identify the nodes of regional polycentricity in OECD large administrative regions (TL2). The latter are chosen as units of analysis, since they represent the first tier of sub-national government in OECD countries and are sufficiently comparable in terms of functions. Figure 4 shows two TL2 regions in Europe of similar area size, namely Aragon (Spain) and Brittany (France), which appear to have very different spatial structures. The former is characterised by one single major metropolitan area only (Zaragoza), while in the latter region several small and medium sized FUAs co-exist with the metropolitan area of Rennes. Close by FUAs – especially when sharing a common higher administrative tier – are often involved in co-operation initiatives for purposes of economic development strategy or service provision and recent OECD analyses provide several examples in this respect (OECD, 2013b).

Figure 4. Monocentric vs. polycentric regional spatial structures: The case of Aragon (Spain) and Brittany (France)



Source: Authors' elaborations from OECD (2012), *Redefining "Urban": A New Way to Measure Metropolitan Areas*, OECD Publishing, doi: [10.1787/9789264174108-en](https://doi.org/10.1787/9789264174108-en).

Through a consistent delineation of FUAs regional polycentricity across 29 OECD countries is assessed quantitatively in this section, which then explores how polycentricity is associated to the level of regional economic development. The first step consists in identifying a measure of polycentric development. In principle, a complete and sound measure of polycentricity should take into account the population size of centres, their distribution and their connectivity (Wegener, 2013). Considering all these dimensions at the same time helps not to lose too much of the complexity of polycentric spatial structures and to adopt at the same time some morphological (size and distribution) and functional (connectivity) features. However, this may imply the use of composite indicators, which are more discretionary and require a much higher amount of data. For the purpose of this paper, simple and straightforward measures of polycentricity for regions and countries have been preferred, following existing literature (Meijers and Sandberg, 2008; Veneri and Burgalassi, 2012). The first is the urban primacy, which considers the share of population in the most populated city over the total regional population or over the sum of the urban population of a region. For the OECD TL2 regions, urban primacy is here defined as the share of population in the most populated FUA over total regional population. Intuitively, the higher the primacy the higher the regional monocentricity.

Polycentricity at regional (and national) scale can also be measured through the *beta* coefficient of the following equation:

$$\ln(rank) = \alpha + \beta \ln(size) \quad [2]$$

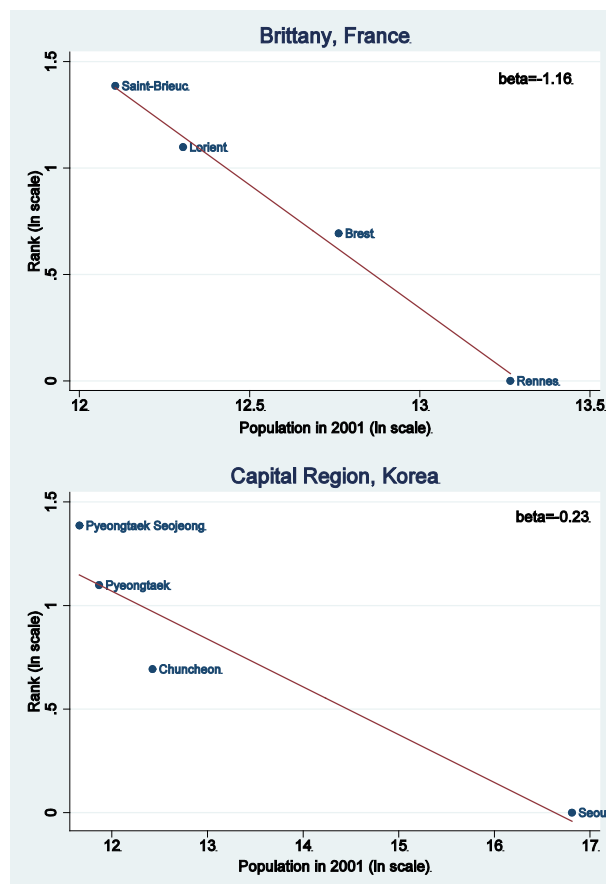
where *size* is total population of each FUA within a given region; *rank* is the rank, computed by region, of functional urban areas by size. The slope of the line interpolating data, given by the estimated *beta*, indicates the level of hierarchy among functional urban areas, and thus the level of polycentricity of each region. By definition, the *beta* coefficient is negative. In absolute terms, the higher the value of *beta* – hence the steeper the line interpolating data – the higher the level of polycentricity. The use of functionally defined urban areas as building blocks for regional polycentricity allows *beta* coefficients to approximate the hierarchical distribution of cities over regional territory without making the mistake of considering places that are part of a single integrated area (e.g. municipalities) as separated nodes of the urban systems (Kloosterman and Musterd, 2001; Parr, 2004).

Matching FUAs with TL2 administrative boundaries is not always straightforward. Some large FUAs (e.g. Paris, Prague, etc.) cover a space that is larger than the administrative region where they are located. In some other cases, several FUAs fall within the boundaries of one single region. In order to minimize possible inconsistencies, FUAs are allocated to regions on the basis of the location of the urban core only. However, all indicators of spatial structure, such as primacy and polycentricity, are computed by considering data at the level of the whole FUAs (both cores and hinterlands). Adopting this method, there are still regions with a value of urban primacy that is larger than 1. This can happen when FUAs' cores cross different administrative regions. In order to avoid biases – and for the sake of simplicity – these regions have not been considered in the analysis.

In this work, the *beta* coefficient of equation [2] was estimated for each TL2 region in order to assess their degree of polycentricity. Clearly, not all the regions have FUAs inside their territories. Some have no FUAs, while others have just one, hence they are considered as monocentric. Some regions have two or more FUAs, so they are polycentric. Consistently with Meijers and Burger (2010) coefficients of equation [2] were estimated taking into account, for each region, the four largest FUAs only, so as to ensure consistency in the number of observations considered and a consequent higher comparability among regions. Figure 5 shows the rank-size distribution of the four main functional urban areas in the Capital region of Korea and Brittany (France). A steeper slope of the line interpolating data indicates a higher degree of polycentricity. The Korean Capital Region is the one

with the lowest level of polycentricity among 147 OECD regions with at least 4 FUAs within their respective territory.

Figure 5. Rank-size distribution of functional urban areas in Brittany (France) and Capital Region (Korea)



Source: Authors' elaboration on OECD Metropolitan Database.

Primacy and polycentricity represent two key features of regional spatial structure. A regression analysis was carried out in order to provide some first international evidence on how regions characterised by a presence of several cities of similar size – hence those that are more polycentric – are associated to socio-economic conditions. According to the hypothesis of “borrowing size” the advantages emerging from large agglomerations should be compensated by a polycentric spatial structure. More specifically, this relationship was explored by looking at how the levels of regional GDP per capita are associated with characteristics of spatial structure, after controlling for other basic factors.

Data used in the analysis come from the OECD regional and metropolitan database. The dependent variable is the natural logarithm of GDP per capita expressed in Purchasing Power Parity US\$. Independent variables included in the analysis are the following: *size* is the total regional population; *education* is the share of workforce holding tertiary education; *primacy* is the share of population in the largest FUA located in the region over total regional population; *d_polycentricity* is a dummy equal to 1 when the region has at least two FUAs in its territory, 0 otherwise; *beta*polycentricity* is a direct measure of the degree of regional polycentricity and it is computed as the interaction between *d_polycentricity* and the *beta* coefficients of the rank-size equation [2];

metro_share is the share of regional population that live in FUAs; *d_East_Europe* and *d_West_Europe* are dummies equal to 1 when the region is located in Eastern European countries or Western European countries, respectively.² These dummies were included in order to control for the spatial heterogeneity in OECD countries and for some peculiar characteristics of Europe related with both spatial development and policy. In fact, the idea of preserving the polycentric development that historically characterises European territory has been shaping the EU spatial policy (Davoudi, 2003). All the variables refer to 2010.

Table 2 reports the results of different model specifications. Model 1 considers primacy only (share of regional population living in the largest city) as feature of spatial structure, while Model 2 considers polycentricity. Model 3 includes both primacy and polycentricity, while Model 4 controls for the total share of people living in FUAs instead of the primacy. Model 5 and 6 include country dummies and hence take account of other unobserved factors at country level that are associated with differences in GDP per capita. These different specifications help interpreting results with more robustness, also given possible collinearity among different variables of spatial structures (*primacy* and *beta*polycentricity* show a linear correlation of -0.39).³

Results confirm that once controlling for overall size, education levels, macro-geographical location and country effects, spatial structure still matters. The first result to emerge is that regions where a larger part of the population is located in the largest FUA (higher primacy) have, on average, higher GDP per capita. This result is consistent with previous analyses focusing on single countries or in Europe only (Cervero, 2001; Vandermotten et al., 2007; Veneri and Burgalassi, 2012). Regarding polycentricity, the sign of the coefficient related to the *beta*polycentricity* variable shows that regions characterised by a lower degree of polycentricity – those with a more hierarchical system – are associated to higher levels of GDP per capita, consistently with other studies focusing on single countries (Veneri and Burgalassi, 2011; 2012). This result does not support the hypothesis that higher levels of GDP per capita are correlated to a polycentric structure of urban centres of different sizes (i.e. that smaller urban centres can functioning like larger ones by “borrowing size” from the larger ones in the same region). The relationship between polycentricity and GDP per capita becomes weaker when controlling for country dummies, but still statistically significant. On the other hand, the extent to which one single or more functional urban areas are located within regional territories emerges as not correlated with the dependent variable (*d_polycentricity* is not statistically significant). Regarding the other variables included in the analysis, regional size and the share of people with high education are associated with higher levels of GDP per capita, consistently with expectations and with existing literature. The coefficient related to the total share of urban population, instead, does not emerge to be statistically significant.

These results should be seen as a preliminary exploration of a complex and multi-faceted relationship between spatial structure and regional socio-economic conditions from an international comparative perspective. The need to use different measures of polycentricity that can account also for the connectivity among urban centres should be taken into account. In addition, linking the self-organisation of the territory (FUAs) with the administrative structure (TL2 regions), is not obvious, since, by definition, functional territories can easily cross regional administrative boundaries. This makes it more difficult to allocate FUAs to the “right” administrative entity.

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2. Among the countries included in the analysis, those considered as Eastern European ones are Czech Republic, Estonia, Hungary, Poland, Slovenia and Slovak Republic.
 3. In any case, all models show a low Variance Inflation Factors, which suggest no problems of multicollinearity.

Table 2. OLS estimation results. Dependent variable: GDP per capita in 2010 (US\$, PPP)
Robust standard errors are reported in brackets.

Variable	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
constant	-5.933	(0.432)***	-6.424	(0.506)***	-6.271	(0.509)***	-6.245	(0.518)***	-3.656	(0.242)***	-3.466	(0.318)***
size	0.085	(0.028)***	0.128	(0.037)***	0.122	(0.038)***	0.121	(0.038)***	-0.010	(0.022)	-0.029	(0.031)
education	2.420	(0.345)***	2.399	(0.341)***	2.546	(0.341)***	2.559	(0.345)***	2.391	(0.566)***	2.812	(0.502)***
d_East_Europe	-0.037	(0.093)	0.059	(0.097)	0.066	(0.098)	0.062	(0.099)				
d_West_Europe	0.354	(0.074)***	0.418	(0.073)***	0.423	(0.073)***	0.422	(0.074)***				
primacy	0.372	(0.134)***	0.256	(0.137)*					0.303	(0.079)***		
d_polycentricity			-0.052	(0.112)	-0.055	(0.113)	-0.167	(0.061)***			0.062	(0.077)
beta*polycentricity			-0.149	(0.058)**	-0.170	(0.057)***	-0.048	(0.114)			-0.045	(0.026)*
metro_share							-0.017	(0.075)			0.048	(0.059)
Number of obs.	206		206		206		206		206		206	
Adj. R-squared	0.376		0.402		0.395		0.393		0.810		0.799	
Country effects	no		no		no		no		yes		yes	
Mean VIF	1.17		1.38		1.39		1.40		8.49		8.16	

Note: * Statistically significant at 10% confidence level; ** statistically significant at 5%; *** statistically significant at 1%.

Source: Authors' elaboration on *OECD Regional and Metropolitan Database*.

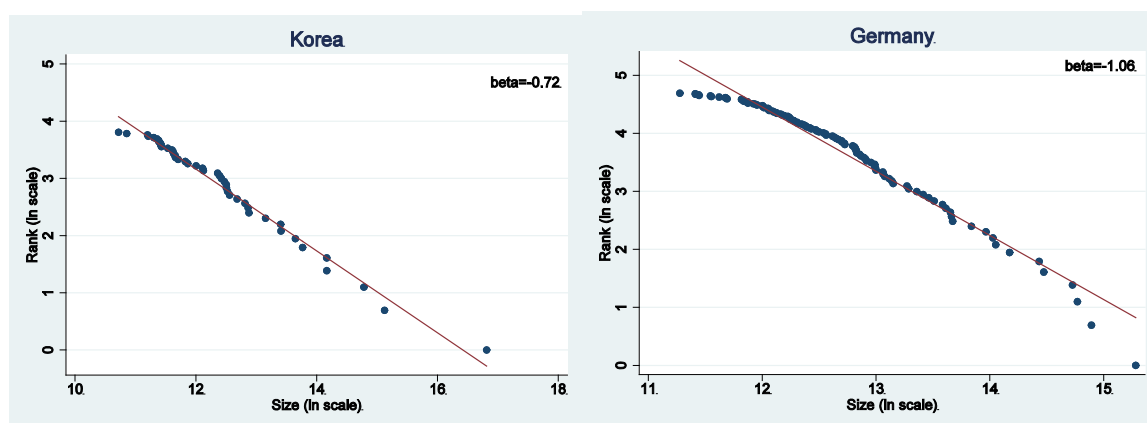
5. Polycentric development at country level

Assessing the polycentric structure of national urban systems is a relevant task for policy. Especially in the current economic downturn that many OECD countries have been facing in the last few years, there is a need to understand what contribution to national prosperity comes from the different regions and whether investment priorities should move towards few large and capital cities or spread in a wider set of cities (Parkinson et al., 2014; Dijkstra et al., 2013). In Europe, a polycentric spatial development is seen as a tool to ensure a more balanced, competitive and sustainable territorial development (ESDP, 1999). In this respect, a research question emerging from this policy framework concerns the role of polycentricity as a way to achieve better development and lower inequalities at country level.

The spatial structure of national urban systems has been studied since long time. Overall, the empirical evidence points that the distribution of cities over space follows a power law – mostly in the form of a Pareto distribution –, meaning that the product of the rank and the size of cities is a constant (Cheshire, 1999; Gabaix and Ioannides, 2004; Veneri, 2013b). Several theoretical explanations have been provided for this empirical evidence, from random shocks related with population migration, productivity and innovation (Gabaix, 1999; Eeckhout, 2004; Duranton, 2007) to Christallerian approaches based on functions played by cities of different sizes (Hsu, 2012). Notwithstanding the robust evidence on the regularity in the relationship between rank and size of cities at national level, spatial structures of urban systems differ across countries. Some countries are more polycentric than others, meaning that they are organised around a flatter urban hierarchy, where the latter is reflected by the coexistence of more cities of similar size, especially in the right tail of the size distribution.

Consistently with the interpretation carried out at regional level, the rank-size relationship of the FUAs located in a country gives an idea of the relative importance of large and small cities as well as a measure of the degree of national polycentricity. Higher values of *beta* coefficients (in absolute value) from the rank-size estimation indicate a higher degree of national polycentricity. Figure 6 plots the rank-size relationship in natural logarithm scale for the national urban systems of Korea and Germany. The higher absolute value of the *beta* coefficient for Germany indicates a higher degree of polycentricity compared with the Korean urban system.

Figure 6. Rank-size distributions of functional urban areas in Korea and Germany



Source: Authors' elaboration on OECD Metropolitan Database.

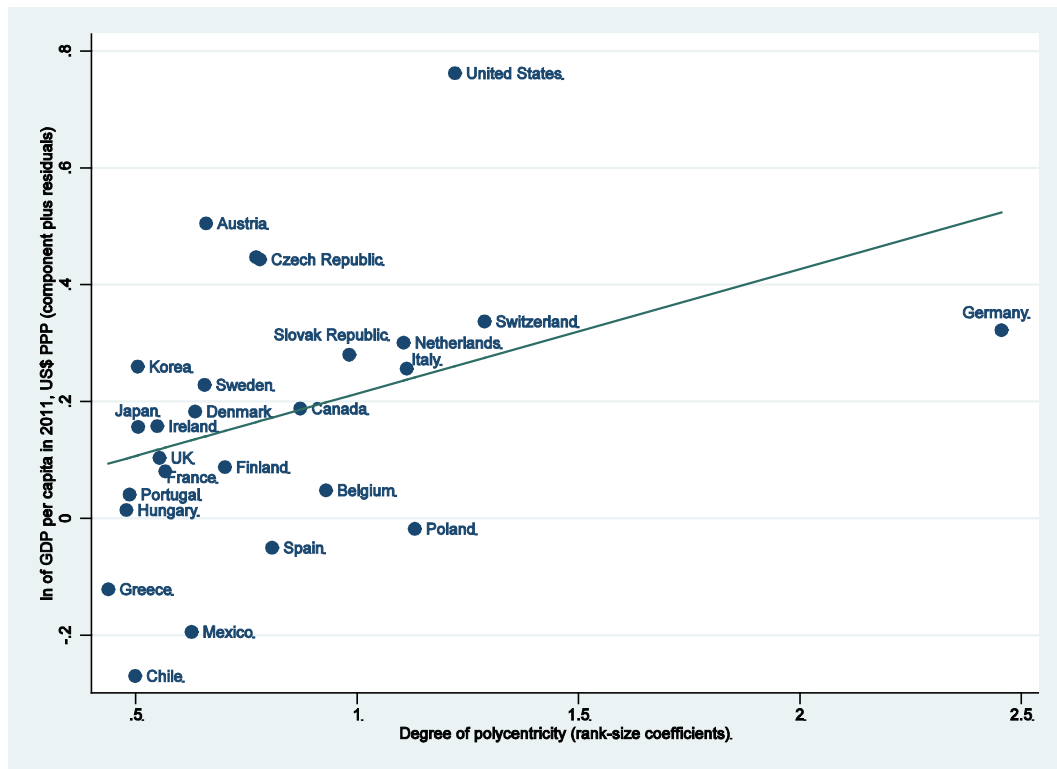
In order to measure and compare the degree of polycentricity of national urban systems, *beta* coefficients were estimated using, for each country, the four largest FUAs only, consistently with what previously done at regional level. This choice allows comparing 26 OECD countries, excluding only Luxembourg, Estonia and Slovenia, which have 1, 3 and 2 FUAs, respectively. Focusing on the four largest FUAs is also a way to better account for the differences in size – and hierarchical relationships – among the largest cities, also catching some aspects of urban primacy.

At national level, the degree of polycentricity appears to be positively correlated with average levels of economic prosperity in the 26 OECD countries considered. This result is represented in Figure 7 (partial residual plot), which shows that more polycentric countries show on average higher levels of GDP per capita. The figure plots the relationship between the degree of polycentricity (*beta* coefficients at national level) and the natural logarithm of GDP per capita expressed in Purchasing Power Parity US\$ in 2010 after having controlled for few other basic variables in a simple linear model.⁴ Controls include the degree of urban primacy, the share of workforce holding tertiary education (*education*) – all referred to 2010 – and two dummies equal to 1 when the country is located in Eastern Europe or Western Europe, respectively. While it must be acknowledged that the limited number of observations and the cross-country nature of the regression analysis make it possible only a first description of the relationship under investigation, it is interesting to note that this result is opposite to the one emerging at regional level.

The result plotted in Figure 7 suggests that polycentricity at country level does not seem to reflect the borrowing size mechanism that was hypothesised at the regional scale. In fact, urban and metropolitan areas in polycentric countries are not necessarily located in close proximity and network relationship might be less important. The potential advantages of polycentricity at the country scale in terms of economic conditions may come from lower levels of agglomeration costs, which can be spread throughout several FUAs. Another possible explanation is that in a more polycentric structure a bigger part of the national territory benefits from being close to at least one large FUA compared to, for example, a situation where people is more concentrated in just one large FUA. As far as urban primacy is concerned, this turned out to be not associated with the levels of GDP per capita.

4. All the variables have been computed from the *OECD database*, <http://dotstat.oecd.org/Index.aspx>.

Figure 7. Degree of polycentricity and GDP per capita at national level, 2010 (partial residual plot)



Source: Authors' elaborations on OECD data, <http://dotstat.oecd.org/Index.aspx>.

6. Concluding remarks

This work contributes to the understanding of the spatial structure of urban systems and its relevance for policy. It focuses on polycentricity, which is defined and treated separately at three different spatial scales: metropolitan, regional and national. The conceptual definition of polycentricity as well as the indicators used to measure such phenomenon builds on a consistent definition of FUAs across OECD countries. FUAs are used as building blocks to assess, on a wide international basis, the polycentric spatial structure of metropolitan, regional and national urban systems.

The possibility to compare a large set of different OECD countries imposed a high approximation in the measures adopted to assess polycentricity. It has to be specified that this work considers polycentricity mainly in its morphological dimension, not taking into account the connectivity among centres, which, especially at regional level, is an important dimension of this phenomenon. In this respect, two possible refinements of the analysis could be considered. First, further effort is needed to harmonize other information available across different countries in order to assess polycentricity in a more comprehensive way. This includes, for example, the possibility of using data on inter-urban flows, such as commuting, trade and/or other socio-economic linkages to assess the degree of interconnection among urban centres in a polycentric region. Second, compiling annual time series for the relevant variables on the functional urban areas would allow longitudinal analyses to be carried out, providing more robust empirical evidence on the relevance of spatial structures in shaping socio-economic processes of countries, regions and metropolitan areas.

Assessing spatial structure and polycentricity has different potential implications for policy making at the three spatial levels considered. At the metropolitan level, the way people and economic activities are distributed across space raises important issues of efficiency in terms of public service provision, face-to-face interactions among economic agents, efficiency of transport and environmental issues connected with patterns of land development (e.g. sprawl). At the regional scale, spatial structures can influence economic development. More specifically, the presence of large metropolitan areas enhances agglomeration economies and consumption benefits. A polycentric spatial structure characterised by a network of cities has been thought to have the potential to compensate for the advantages of a single large agglomeration (borrowed size hypothesis, see also Burger et al., 2014). However, our preliminary empirical exploration suggests that lower polycentricity and higher urban primacy are associated with higher GDP per capita. This may suggest that physical distance and agglomeration of people and workers have an important role for socio-economic conditions in regions.

These first descriptive results suggest that the meaning and the policy significance of polycentricity depends on the scale at which it is observed. Polycentricity has been representing an important policy goal in the European policy discourse, where polycentric development is also seen as a policy tool to reach a more balanced development, hence lower territorial disparities. However, the main message emerging from this paper is that policy aimed at fostering polycentricity should be referred to specific spatial scales and should be more informed on the possible implications in economic and environmental respects. In order to understand such implications, further research is needed.

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