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Polycentricity and Social Services of General Interest: A Multivariate Analysis

Pedro Palma^a, Daniel Rauhut^b & Alois Humer^c

Abstract

The aim of this study is to discuss the impact of polycentric structures and other regional patterns on the provision of Social Services of General Interest (SSGI). The theoretical background on SSGI provision builds upon the elaborations of ESPON/SeGI project that defines SSGI as an open, normative EU policy field, nevertheless linked to national understandings of public services.

A multivariate cross-section OLS regression model is used to estimate the relative impact of polycentricity on our dependent variables which is the provision of educational and health care SSGI in EU and EFTA countries. The chosen method enables to control for a subset of explanatory variables and examine the effect of selected independent variables when estimating the impact of polycentricity to the provision of SSGI. This study uses Eurostat and ESPON data.

The findings indicate that polycentricity on national level appears to have an impact on low and medium centrality services. Spatial patterns are revealed especially in Central Europe for both kindergartens and hospital beds, while the absence of polycentricity is shown for the Nordic countries regarding kindergartens.

JEL: R12, I31, H41

Keywords: Social Services of General Interest, polycentricity, centrality, multivariate regression

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1 INTRODUCTION

The European Spatial Development Perspective (ESDP) is seen as a milestone of European spatial strategy, and sets three main objectives to pursue territorial cohesion: a) to define a polycentric and balanced urban system between urban and rural areas; b) promote universal access, for all regions, to infrastructures and knowledge; c) sustainable management of natural and cultural patrimony (CEC, 1999). With the ESDP regional development change to a more widely and integrated supranational vision. It relates with economic zones of global integration able to promote a polycentric spatial pattern on behalf of the traditional concentration characteristic of the core-periphery model (Ferrão, 2002). The paradigm change is one of the most important aspects of European spatial strategy, and it is often stressed that a polycentric pattern is a major spatial policy objective (Faludi, 2006; Council of the European Union, 2006, Territorial Agenda, 2011) in order to provide economic competitiveness and social and territorial cohesion to Europe (CEC, 1999; CEC, 2001; Davoudi, 2002). The need to provide empirical evidence for these theoretical assumptions has been emphasized by several scholars (Davoudi, 2002; Meijers and Sandberg, 2006; Wegener, 2013).

Since the ESDP (1999) a polycentric development is increasingly mentioned within the framework of cohesion policies, equity and regional development. Several studies suggest a relation between the services provision and the urban system configuration (Meijers, 2006; Faludi, 2005; Zonneveld & Waterhout, 2005, Meijers et al., 2007). It is however noted that this relation awaits empirical evidence (Borges and Johansson, 2012).

The monocentric pattern is characterized by a well-defined centre that concentrates the majority of resources and population, maintaining unidirectional functional relations with smaller centres. This determines a higher services concentration in the major urban centres and leads to higher rates of services available per capita (Borges and Johansson, 2012).

In the case of remote and peripheral areas the situation is quite different. The demand is most of the times, higher than the offer. In a theoretical perspective the trend is to increase disparities due to the concentration of services in the major urban centres and disregard the peripheral territories (Meijers and Sandberg, 2006; Wegener, 2013; Borges and Johansson, 2012), with possible negative impact on territorial and social cohesion. In other hand, and following the growth pole theory by Perroux (1955), the concentration of resources can suggest better conditions to face financial problems which are somewhat typical of peripheral territories. Thus, in the case of spread settlements and areas of low population density, the

monocentric urban system can bring some advantages by saving resources (Rauhut et al. 2013).

In the polycentric pattern there is no major urban centre, and so, there are no major concentrations of population or resources. It is characterized by several centres of intermediate size that establish functional relations between them, promoting a more uniform spatial distribution and thus can constitute a relevant prerequisite for territorial cohesion. Meijers and Sandberg (2006) refer to the term as a plurality of centres in a given area, without a strong hierarchy, and highlight that it can be applied to a wide variety of scales, from Europe, to countries, regions or even cities.

In theory, regarding the provision of services, the polycentric configuration represents a more equitable spatial distribution across the territory. Given this assumption and considering countries with high population density, the polycentric pattern is assumed to better assure the sustainability of services based on the market. The demand is significant enough to ensure the services provision, contrary to what is expected in peripheral territories in a monocentric urban system (Borges and Johansson, 2012).

The few empirical studies analysing what impact polycentricity has on service provision postulate that all that services operate at the same level or scale. According to the Central Place Theory, the services provision is dependent on if the service represents a low, medium or high centrality service (Milbert et al. 2013:43). It has been noted that low centrality services are well provided in both urban and rural regions, and that medium centrality services are well provided in urban regions but not in rural regions. High centrality services are well provided in urban regions, but poor in rural regions (Rauhut and Komornicki 2015). It can hence be assumed that polycentricity will have a different impact on different services depending on the level of centrality of services.

The aim of this paper is to discuss to what extent a polycentric urban structure represents a more efficient provision of three selected Social Services of General Interest (SSGI) in 25 European countries. The three selected services are the number of hospital beds per 100,000 inhabitants, the share of students, ISCED 5-6, in total population and formal child care from 3 years old to compulsory school, as a share over the population in the age group. This paper proposes to answer the following questions: (1) does polycentricity have a positive impact on the provision of the three analysed SSGIs regardless if it is a low-, medium- or high centrality service?; and (2) does polycentricity have a different impact on the provision of SSGIs in different parts of Europe?

Services of General Economic Interest (SGEI) was briefly mentioned in Article 86 of the Rome Treaty, 25 March 1957; the broader notion of Services of General Interest (SGI) was only developed in relation to the Treaty of Amsterdam, 2 October 1997, while the term Social Services of General Interest (SSGI) only emerged in the Presidency Conclusions of the Laeken European Council meeting 14 and 15 December 2001 (Smith and Rauhut, 2015:1). Indeed, SGI and its social sub-category Social Services of General Interest (SSGI) have attained a level of recognition at the EU level that remains puzzling. Unlike SGI and SGEI however, SSGI currently supports no legally binding definition – there is no Treaty basis for SSGI and the Member States (MSs) cannot agree on its boundaries (van de Gronden 2011:150-51; Bauby 2013:50-51). In broad terms, SSGI are seen as measures addressing risk and vulnerabilities in life (European Commission 2007: 7-8), which facilitate social inclusion and the safeguarding of fundamental rights (European Commission 2010: 16-17).¹

The paper is structured the following way. In the second section, we give a short literature review on polycentricity and its effect on SSGI. The third section will line out the conceptual framework used for the analysis and section four contains a discussion on data and method. In section five, we present an empirical analysis and section six presents a discussion and conclusion.

2 LITERATURE REVIEW

The concept of *polycentrism* is related to a normative agenda on achieving two European policy goals: the social and territorial cohesion and the economic competitiveness (Governia and Salone, 2005). In fact, this concept was early considered as a “bridging concept” in the sense that could combine different interests of the member states around the policy objectives of cohesion and competitiveness. According to Waterhout (2002), the polycentricity concept allows to consider both objectives.

It was widely adopted in the European community as a spatial concept which is expected to contribute to the policy goal of territorial cohesion (Faludi, 2005; Zonneveld and Waterhout, 2005), addressing crucial challenges of Europe. One of them was identified in ESDP as the need to counterbalance the European core that promotes an unbalanced European spatial development, by the creation of several dynamic zones of global economic integration,

¹ The notion of SSGI has, in part, been used by the CEU as one of a number of tools and/or strategies designed to ‘shape’ the policy making environment in the EU Social Policy field – a field in which EU institutions ostensibly have only limited powers *vis-a-vis* the MSs (Bauby 2011: 34-35).

well distributed over the territory (CEC, 1999). The reinforcement of polycentrism is seen as a strategy to face this specific challenge (Baudelle and Castagne`de, 2002).

In the debate following the ESDP, conceptual issues of polycentrism arose. While the concept itself is widely used, it remains elusive as it display different phenomena at different scales. (Kloosterman and Musterd, 2001; Davoudi, 2003; Hague and Kirk, 2003). The lack of a clear conceptual definition of polycentrism is in line with the conceptual criticism, which has been pointed by several scholars. (Davoudi 2004; Faludi 2005; Nadin and Dühr 2005; CEC, 2009; Salez, 2009).

One of the most critical aspects on the interpretation and applicability of polycentrism is the scale factor (Shaw and Sykes 2015). In this particular aspect, the European Commission's second report on economic and social cohesion (CEC, 2001) consider two levels in which polycentricity can occur: at the EU level and at regional level. Two other levels are also mentioned, but not given the same importance: the national level (Brezzia and Veneria, 2015) and the agglomeration level (Tewdwr-Jones and Williams, 2001; Davoudi, 2002).

In the scientific community it is recognized that polycentricity can occur at different scales. This raises hence methodological challenges related to issues of interpretation and application of polycentricity. Furthermore, it is debated to what extent it is possible to achieve polycentrism simultaneously at all the scales (ESPON 2005). From a theoretical perspective, the promotion of more polycentric development at regional level can lead to major differences between the core of Europe and these regions. Potential contradictions may be found, what is monocentric at one level can be polycentric at another one – and vice versa (Hall and Pain, 2006; Taylor et al., 2003). The “pentagon” – the area covering London-Paris-Milan-Munich-Hamburg-London – is the only European geographic zone of global economic integration (ESPON, 2005; Meijers and Waterhout, 2007; Hague and Kirk, 2003). It represents a polycentric structure, trans-national in scale, comprising some urban regions with several cities of equivalent size and interlinkages between them (Hague and Kirk, 2003; Vandermortten et al., 2008). At a different scale, some smaller polycentric urban structures emerge. Hall and Pain (2006) studied eight regions across Europe, most of them located within the pentagon. The results prove that two from these eight regions are strictly polycentric, with no dominant city (the Randstad and Rhine-Ruhr regions).

Some other studies rather focus on a national scale and evaluate the level of polycentricity of national urban structures. Meijers and Waterhout (2007) built a polycentricity index for 26 European countries and found out that the most polycentric

countries are: Slovenia, Ireland, Poland, Denmark and Netherlands. On contrary, the most monocentric countries founded are: Norway, Finland, Spain, Hungary, Portugal and Sweden.

Apart from the existence of diverse methodologies to measure polycentricity, several empirical analysis identify it at different scales, but even more relevant is to demonstrate its significance within the European spatial strategy and to recognize its relevance to pursuit the outlined goals.

Few empirical studies have been made on the effects or impact of polycentricity. Most doing so resort to relate the degree of polycentric development with some economic, social and environmental performance. Veneri and Burgalassi (2012) research concerns the Italian NUTS2 and the results shows that polycentrism “is not always a virtuous model of spatial development, especially in terms of social cohesion. The authors go further and state that polycentric spatial structure...is far from being an effective tool to reach those important policy aims highlighted by the ESDP” (Veneri and Burgalassi, 2012: 1034-1035). These conclusions goes against the ESDP, but are in line with other studies. The research of Meijers and Sandberg (2006) also points in the same direction. The authors analyze the relation of polycentrism with regional disparities and demonstrate that more polycentric urban structures tend to present higher regional disparities.

Regarding the relation between polycentrism and the provision of services of general interest, the studies are scarce. Borges and Johansson (2013) made one of the rare attempts on it through the use of polycentricity indexes and SIG indicators. No relations could be seen between polycentricity and SSGI. The findings by Meijers (2008) can be mentioned here as well. He discussed if a polycentric urban region can gain advantages in the provision of cultural, leisure and sports amenities. Even with different centrality levels, the results show that the more polycentric a region is, the fewer amenities exist, on contrary, more monocentric regions tend to present more amenities.

In general terms, it is recognized that the existence and significance of polycentricity depend on the scale the scale (Brezzi and Veneria, 2015). The need to prove the theoretical basis of polycentrism with empirical studies is also widely mentioned across the academic community (Davoudi, 2002; Meijers and Sandberg, 2006; Wegener, 2013).

The ESDP was published in 1999 and after almost two decades of the concept adoption, its empirical basis is still rather weak. As a normative policy with cohesion and competitiveness objectives, it still needs a solid empirical demonstration. This paper seeks to contribute to fill (parts of) the gap between the theoretical assumptions and empirical evidences around the concept of polycentrism.

3 CONCEPTUAL FRAMEWORK

In this section, the two main ingredients, Social Services of General Interest and territorial structures - in more detail: polycentricity - will be conceptually discussed and interlinked. A theoretical background behind (Social) Services of General Interest lies within the wide literature on public goods and services (Humer, 2014b, Bjørnsen et al., 2015). In macro economic theory, public goods are analytically defined as goods that are of non-rival character in terms of production and of non-excludable character in terms of provision (see Buchanan, 1968, Tullock, 1971). In this respect, public goods and services have per se a public character. However, in this statistically empirical exercise, we want to find out more about SSGI as a political-normative concept and therefore we not follow pure theoretical views on public services. It is widely accepted to conceptualize (S)SGI within a politically shaped context out of EU legislation and policy agenda (Fassmann et al., 2015). From an EU understanding, SGI is no equivalent to public services but follow a distinct logic. Public goods and services in a theoretical understanding are explained by collective motives and seen in hands of the public (authorities). Different to that, SGI are explicitly understood as services that can be organised and produced by not only public but also private actors. SGI therefore stands for an own category or normative definition of a group of services. There is no exhaustive list of what services are SGI or SSGI but in a wider understanding, Social Services of General Interest are found within Beveridge's 'five pillars or welfare' - education, health care, labour market, housing and social benefits (Humer, 2014a).

Humer et al. (2015) put the political level into the center of attention when - on a conceptual basis - explaining how SGI provision works, from which drivers it is dependent and by which actors it is co-shaped. The actual provision of SGI is made up in dialogue of organising actors - that can be of public, commercial or civil character - and of demanding/consuming actors - that again can be public or private bodies, households or individuals. How this dialogue takes place is to great extend a matter of the surrounding policy system and practices. In this respect, SGI provision is especially an outcome of a social welfare policy when it comes to production, financing and assigning, and an outcome of spatial planning policy when it comes to organising locations, access to and distribution of SGI (Humer, 2014a).

With all the respect for the prime role of policy systems with regards to SGI provision, a policy system is dependent on several drivers that cannot fully be controlled by policy steering. Concerning SGI provision, the most important drivers (as identified by Humer et al.,

2015) are: demography, society, economy and environment. Aspects of these four drivers can influence the policy arena for SGI provision in many ways. Demographic structures and processes shape the quantities and qualities on the demand side. It does make a difference whether SGI provision is done for a young or old population, population with migration background etc. Societal values impact as well on the policy options and the understanding of what are good standards of SGI provision. Macro and micro economic potentials set the limits of SGI provision in financial respect.

Across all drivers and their attributes, principally speaking, time and space constellations have to be considered. With changing conditions over time or in different regions, different policy options for SGI provision are possible, different modes of organisation and different demands are apparent. In this respect, mono- or polycentric structures shall have an influence on the actual SGI provision but cannot be considered to be a driver as such. As discussed in the literature section above, polycentricity is a scale-dependent concept. The question of scale has not been too much into focus of SGI related research so far. Milbert et al. (2013) refer to the Central Place Concept with regards to spatially organizing SGI. SGI of different degree of specialization and outreach should be located in different hierarchies of places. While fairly ubiquitous services like kindergarten are provided in places of all hierarchy levels, more specific SSGI like labour market agencies, hospitals or tertiary educational facilities are most efficiently placed in cities of medium to higher centrality within the hierarchical system of settlements.

Scale and spatial hierarchy may function as a linking piece in the conceptual discussion of SSGI and polycentricity. As discussed in the literature review above, it depends on the scale - sub-local to supra-national - if a territory is of polycentric character. In this empirical study, we work with polycentricity from a national perspective, while on the other hand, we introduce various SSGI of different centrality levels. This should allow for a scale-sensitive test in which we keep the scale of polycentrism stable but introduce stepwise SSGI of low, medium and high centrality.

While in the above described drivers' concept by Humer et al. (2015), the discussion remains on a non-empirical basis and therefore weighting of single drivers and their indicators is not done, Humer and Palma (2013) did a small empirical study across the NUTS2 regions of Europe in which they came to a result that declared territorial and (macro) economic indicators as most decisive for the level of SGI provision of a region. While demographic and societal indicators had less explanatory value, it was foremost settlement patterns (i.e. rurality-urbanity), population density and economic prosperity that correlated high with

provision standards of SGI in European regions. The only independent variable in this case was a highly aggregated SGI index that didn't allow for a single interpretation of certain SGIs nor of SGIs of certain centrality levels. These shortcomings are of concern in this paper. The hypotheses that settlement patterns - such as polycentricity - population density and regional economic conditions do impact on the provision of SGI - of different centrality level - can be set out for testing.

4 DATA AND METHOD

The empirical analysis in this paper is set at a national level. The data availability places several data constraints and this is the main reason for this decision. Since the ESDP that the pursuit of polycentric development is one of the major spatial objectives of a large group of Member States (ESPON, 2005), and the formal competencies on territorial development lies on them, and not on the EU level. In addition to this operational viewpoint, the relevance of the national scale in designing European policies is recognized by Meijers and Waterhout (2007). The national approach may thus become very relevant as an input to the debate around spatial development.

This study uses macro data collected from Eurostat and cover the year 2010. Eurostat has harmonised the data from the national statistical offices to enable comparisons between the countries.

A multivariate cross-section OLS regression model will be used for estimating the relative impact on three chosen SSGI's (number of hospital beds per 100,000 inhabitants, share of students, ISCED 5-6, in total population and formal child care from 3 years old to compulsory school, as a share over the population in the age group). This method is chosen because it enables us to control for a subset of explanatory variables and examine the effect of a selected independent variable when estimating the effect on SSGI provision.

The analysed countries are listed in table 1 below. In total 24 EU countries and Norway are analysed in this study. To analyse effects of polycentricity is, according to us, not meaningful to do in countries as Cyprus, Liechtenstein, Luxembourg and Malta. They are simply geographically too small for the concept of polycentricity to make sense. Croatia and Switzerland are excluded they are not included in the study by Sandberg and Meijer (2006).

Table 1: The analysed countries and classification codes (dummy variables)

Country	Dummy	Country	Dummy	Country	Dummy	Country	Dummy
BE	C	GR	S	HU	E	SI	E
BG	E	ES	S	NL	C	SK	E
CZ	E	FR	C	AT	C	FI	N
DK	N	IT	S	PL	E	SE	N
DE	C	LV	E	PT	S	UK	C
EE	E	LT	E	RO	E	NO	N
IE	C						

C= Central Europe; E= Eastern Europe; N= Northern Europe; S= Southern Europe

The dependent variables will be analysed: 1) number of hospital beds per 100,000 inhabitants, 2) the share of university studied students (ISCED 5-6) in total population and 3) formal child care from 3 years old to compulsory school, % over the population in age group. The independent variables chosen in this study are: GDP/capita, population density, a polycentricity index, and variables of interaction are created by multiplying GDP/ capita with a dummy for where in Europe the country is located. The dummies are listed in table 1.

Variables such as GDP/capita and population density do not require any explanation, but the dummies and the variables of interaction do. A dummy is used for measuring qualitative differences in the variables and the main rule is to use one dummy less than the number of categories (Ramanathan 1995: 332, 339). Medical care, educational systems and kindergartens are very much related to the functions of the welfare state and different welfare regimes exist in Europe (Esping-Andersen 1990, 1996). Some of the welfare regimes identified in the scientific literature is related to GDP/capita and different levels of welfare provision can be explained by different levels of GDP/capita (Vogel 2003). Borges and Johansson (2012) also found GDP/capita as a major determinant for the provision of health and medical care and education. In line with these findings we have constructed three dummy variables: one dummy for Eastern Europe (Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia) one for the Northern Europe (Denmark, Finland, Norway and Sweden), and one for Southern Europe (Greece, Italy, Portugal and Spain). A dummy variable is *not* used for countries classified as Central European (Austria, Belgium, Germany, France Ireland, the Netherlands and the U.K.). The dummy for the Nordic countries respond well to characteristics in their welfare systems and so do the dummy for the southern countries. The dummy for the East European former communist countries mirror the transition economies and the welfare challenges these countries are experiencing. When multiplying the dummies with GDP/capita, a variable of interaction is constructed in order to highlight the qualitative differences in the welfare provision related to different levels of GDP/capita.

In order to control for qualitative differences in different parts of Europe, the operation with variables of interaction will also be made for population density and polycentricity. The same dummies will be used.

Several attempts to quantify polycentricity have been made. ESPON (2005, 2007) presents two completely different indices on polycentricity; Sandberg and Meijer (2006) present a third one. Although the indices rank the included countries in completely different ways Borges and Johansson (2012) notice that some correlation exists between the Sandberg-Meijer Polycentricity Index (SMPI) and the index by ESPON (2007). In the analysis by Borges and Johansson (2012) the three different indices are discussed in a context of Social Services of General Interest, in general, and in particular the health and care sector as well as the educational sector. The conclusion from their bivariate analysis is that the SMPI appears to produce the most robust results (Borges & Johansson 2012). Based on the findings by Borges and Johansson (2012), the SMPI will be used as a proxy variable for measuring polycentricity in this study.

The dependent variables analysed in this paper operate at different levels of centrality. Hence, we can assume that the impact of polycentricity will be different depending on what services is analysed. A two dimensional ranking in line with Christaller's 'Central Place Theory' and Maslow's 'Hierarchy of Needs' is made by Milbert et al. (2013). Following Christaller, low centrality level services – such as, pharmacies, kindergartens, primary and secondary schools – should be very accessible also in all kind of territories, while high centrality level services – such as universities and specialised hospitals – will not be very accessible in all kind of territories. The middle centrality level services – such as hospitals and employment agencies – are to some extent accessible also in rural areas. Hence, it can be assumed that the closer the rural areas is to a city or urban area, the more of middle centrality level services will be accessible for the population in this kind of territory. The conclusion is that polycentricity will have little impact on the low centrality services as they are provided locally, while polycentricity may have a (significant) impact on medium and high centrality services.

In this study the formal child care from 3 years old to compulsory school, as a share over the population in the age group, is considered a low centrality SSGI (dependent variable 1). A medium centrality SSGI is the number of hospital beds per 100,000 inhabitants (dependent variable 2), and the share of students (ISCED 5-6) in total population is considered a high centrality SSGI in this study (dependent variable 3).

Based upon the conceptual framework and the methodological considerations discussed in this chapter two basic models can be specified. One is a restrictive model, containing the variables discussed in the conceptual framework having an impact on the demand and supply functions of SSGI provision: GDP/capita as a proxy for economic factors, population density as a proxy for demographic factors and polycentricity as a proxy for territorial factors. Hence, the restricted model is specified as:

$$Y = a_1 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon \quad (a)$$

The second model is an extended model, including the three main variables (GDP/capita, population density and polycentricity), as well as variables of interaction. The variables of interaction are calculated with dummies for Northern, Eastern and Southern Europe in combinations with GDP/capita, population density and polycentricity. Hence, the extended models are specified as:

$$Y = a_1 + \beta_1 X_1 + \beta_2 D_N X_1 + \beta_3 D_E X_1 + \beta_4 D_S X_1 + \beta_5 X_2 + \beta_6 X_3 + \varepsilon \quad (b)$$

$$Y = a_1 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 D_N X_2 + \beta_4 D_E X_2 + \beta_5 D_S X_2 + \beta_6 X_3 + \varepsilon \quad (c)$$

$$Y = a_1 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 D_N X_3 + \beta_5 D_E X_3 + \beta_6 D_S X_3 + \varepsilon \quad (d)$$

For each dependent variable the a-d models will be operationalised into 12 regressions: 1a-d, 2a-d and 3a-d.

The natural logarithm has not been calculated for the variables and consequently the coefficients will not express elasticities.

5 ESTIMATIONS AND RESULTS

With one exception, polycentricity appears to have no impact on the share over the population in the age group participating in the formal child care from 3 years old to compulsory school. The exception is the North European countries in model 1d: when polycentricity increases with one unit in monocentric countries, the share over the population in the age group participating in the formal child care from 3 years old to compulsory school decreases with about 0.7 units. This can be interpreted as when polycentricity increases, so does the economies of scale. An excess supply of child care is simply not needed when polycentricity increases. It is important to remember that Denmark, Finland, Norway and Sweden have a well-established nation-wide child care system and a very high female labour force participation rate.

Population density displays a statistically significant coefficient in model 1a, suggesting that when population density increases with one unit the share over the population in the age group participating in the formal child care from 3 years old to compulsory school increases with about 0.5 units. A higher population density can be assumed to result in a higher number of children in need of child care, i.e. the demand for child care will increase when the population density increases. In model 1c we see the same results for central Europe: when population density in Central Europe increases with one unit the share over the population in the age group participating in the formal child care from 3 years old to compulsory school increases with about 0.6 units.

Table 2: Formal child care from 3 years old to compulsory school, as a share over the population in the age group 2010. *t*-stat within brackets

	Model 1a	Model 1b	Model 1c	Model 1d
Constant	42.044 (1.417)	20.160 (.663)	56.688 (1.722)	35.552 (1.201)
GDP/cap	.196 (1.079)	1.052** (3.259)	.255 (1.261)	.316 (.976)
Popdens	.538** (2.910)	.132 (.601)	.592* (2.312)	.134 (.628)
SMPI	-.214 (-1.141)	-.116 (-.639)	-.300 (-1.481)	.007 (.034)
N*GDP/cap		-1.054** (-3.088)		
E*GDP/cap		-.091 (-.481)		
S*GDP/cap		-.147 (-.798)		
N*Popdens			-.289 (-1.488)	
E*Popdens			-.077 (-.299)	
S*Popdens			-.232 (-1.097)	
N*SMPI				-.674* (-2.541)
E*SMPI				-.594 (-1.765)
S*SMPI				-.323 (-1.578)
Adj. R2	0.256	0.441	0.261	0.428
d.f.	21	18	18	18
F-value	3.758*	4.153**	2.412	3.996**

*** Statistically significant at 0.1% level

** Statistically significant at 1% level

* Statistically significant at 5% level

Model 1b displays a positive and statistically significant coefficient for GDP/capita for Central Europe and a negative and statistically significant coefficient for GDP/capita in Northern Europe. When GDP/capita increases with one unit in Central Europe, the share over the population in the age group participating in the formal child care from 3 years old to compulsory school increases with a little bit more than one unit. This can be interpreted as when GDP/capita increases, so will the demand for female labour do. Hence more women will leave domestic work for a paid work, leading to a demand for child care.

In Northern Europe correlation is negative: when GDP/capita increases with one unit in Northern Europe, the share over the population in the age group participating in the formal child care from 3 years old to compulsory school decreases with a little bit more than one unit.

Table 3: Number of hospital beds per 100,000 inhabitants 2010. *t*-stat within brackets

	Model 2a	Model 2b	Model 2c	Model 2d
Constant	73.795 (.339)	84.422 (.422)	210.209 (.927)	272.143 (1.182)
GDP/cap	-.326 (-1.849)	-.053 (-.188)	-.279 (-1.511)	.004 (.011)
Popdens	-.060 (-.335)	-.334 (1.754)	-.206 (-.880)	-.079 (-.360)
SMPI	.478* (2.628)	.430* (2.720)	.386 ^a (1.995)	.238 (1,051)
N*GDP/cap		-.299 (-1.006)		
E*GDP/cap		.453* (2.758)		
S*GDP/cap		-.176 (-1.099)		
N*Popdens			-.144 (-.813)	
E*Popdens			.273 (1.171)	
S*Popdens			-.249 (-1.291)	
N*SMPI				-.327 (-1.198)
E*SMPI				.268 (.773)
S*SMPI				-.297 (-1.409)
Adj. R2	0.297	0.576	0.385	0.394
d.f.	21	18	18	18
F-value	4.387*	6.433***	3.508*	3.596*

*** Statistically significant at 0.1% level

** Statistically significant at 1% level

* Statistically significant at 5% level

^a Statistically significant at 6% level

In table 3 the regression results are shown for the medium centrality service number of hospital beds per 100,000 inhabitants in 2010. The restricted model 2a has a positive statistically significant coefficient for the SMPI. The result indicate that when polycentricity increases with one unit, the number of hospital beds per 100,000 inhabitants increases with just less than 0.5 units. A similar results is found in model 2b, but here the coefficient for GDP/capita in East European countries also display a statistically significant coefficient. When GDP/capita in Eastern Europe increases with one unit, the number of hospital beds per 100,000 inhabitants increases with almost 0.5 units. None of the other coefficients in models 2a-2d are statistically significant.

Table 4: Share of university students in total population 2010. *t*-stat within brackets

	Model 3a	Model 3b	Model 3c	Model 3d
Constant	5.830E-02 (4.797)	7.382E-02 (5.388)	6.766E-02 (4.989)	6.984E-02 (5.202)
GDP/cap	-.183 (-.934)	-.783 ^a (-2.047)	-.257 (-1.172)	-.572 (-1.482)
Popdens	-.407 ^a (-2.042)	-.099 (-.381)	-.343 (-1.234)	-.195 (-.764)
SMPI	-.118 (-.588)	-.327 (-1.518)	-.255 (-1.161)	-.273 (-1.038)
N*GDP/cap		.647 (1.599)		
E*GDP/cap		.039 (.176)		
S*GDP/cap		-.273 (-1.253)		
N*Popdens			.023 (.108)	
E*Popdens			.001 (.004)	
S*Popdens			-.346 (-1.513)	
N*SMPI				.427 (1.347)
E*SMPI				-.001 (-.003)
S*SMPI				-.284 (-1.165)
Adj. R2	0.137	0.215	0.132	0.186
d.f.	21	18	18	18
F-value	2.271	2.097	1.606	1.913

*** Statistically significant at 0.1% level

** Statistically significant at 1% level

* Statistically significant at 5% level

^a Statistically significant at 6% level

None of the coefficients in models 3a-3d for the share of students in total population in 2010, a high centrality service, display any statistically significant coefficients. This result can be interpreted as polycentricity appears not to have any impact on the supply of a higher centrality service such as higher education.

6 DISCUSSION AND CONCLUSION

Despite the empirical attempts to study the impact of polycentric urban structures in SGI, they remain rare and the lack of empirical evidences continues to exist. Some evidence gaps have, however, been filled by this study. When comparing the findings from previous research with the estimations and results provided in this paper several conclusions can be made. The first is that scale matters, which has been pointed out previously (Brezzia and Veneria 2015, Shaw and Sykes 2015, Tewdwr-Jones and Williams 2001, Davoudi 2002).

Secondly, the findings here also support the predictions by Milbert et al. (2013) in their theoretical discussion. Depending on the centrality level of the provided service which is analysed, the results will differ. The low centrality service – in this case kindergarten – indicates an impact of monocentrism: when polycentrism increases in monocentric countries,

the low centrality service kindergarten will decrease. Meijer (2008) discussed the provision of cultural, leisure and sport facilities and the conclusions in his study indicate similar findings. Empirical evidence is also provided by this paper to support that the medium centrality service hospital beds per 100,000 inhabitants are positively influenced by polycentrism. This finding is in line with what Borges and Johansson (2012) found in their explorative study. Finally, the high centrality service students in tertiary education indicate no correlation to polycentrism. This finding may be surprising, but Borges and Johansson (2012) did not find any empirical support on how polycentric urban structures had an impact on education (which is a very wide indicator).

Following the conceptual idea of the SGI drivers model by Humer et al. (2015), the calculated results remind us to better distinguish between *drivers* of SGI provision and territorial (and temporal) *contexts*. From our independent variables, GDP/cap and population density represent economic and socio-demographic drivers while polycentricity is - interpreting the SGI drivers model - actually no driver but more a contextual feature in which the drivers express in different attributes. This perspective is most supported by the results for the low centrality - say ubiquitous - SSGI of child care; it is rather correlated to GDP/cap. and population density than polycentric structures on national level.

The aim of this paper is to discuss to what extent a polycentric urban structure represents a more efficient provision of three selected Social Services of General Interest (SSGI) in 25 European countries. Two questions were proposed to be answered: (1) does polycentricity have a positive impact on the provision of the three analysed SSGIs regardless if it is a low-, medium- or high centrality service? (2) does polycentricity have a different impact on the provision of SSGIs in different parts of Europe? The first question can be answered in a very simple way: the analysis shows that polycentricity (on national level) has an impact on low and especially on medium centrality services. No impact was found regarding high centrality services.

When it comes to the second question, spatial patterns are visible. In the case of low centrality services – kindergartens – the influence is inverted, i.e. the absence of polycentrism impacts the provision of this particular service in the Nordic countries (model 1d). In the analysis of hospital beds polycentricity has an impact in general (model 2a), but the impact by polycentricity on the provision of hospital beds appears strongest in Central Europe (model 2b).

The spatial patterns are especially visible when it comes to the drivers of SSGI provision, demography and economy. The economic indicator GDP/cap poses a significant

impact on kindergartens in Central and Northern Europe (model 1b), while population density has an impact on the kindergartens in Central Europe (model 1c). Regarding hospital beds per 100,000 inhabitants GDP/cap has an impact in Eastern Europe (model 2b).

Reflecting the results conceptually, polycentricity on national scale is relatively speaking most important for the SSGI of regional outreach, hospitals. So we should precise the initial co-discussion of polycentricity-scales and SSGI-centralities in a way that we might have a 1-step-difference when matching the scales and centralities together. Polycentricity on national level implies a well distributed pattern of second-ranked, regionally important cities on the disfavour of a single, prime capital city. Consequently, polycentric patterns on regional level - what was not included in this empirical study - should then exert influence on the provision of low-centrality SSGI. Following the same logic but going scales upwards, SSGI of highest centrality and national importance - such as tertiary education - shall then be influenced by polycentricity on supra-national level.

The debate on the hierarchically shifted relation between polycentricity-scales and SSGI-centralities is only hypothetic at this stage. Further empirical evidence would be needed, for which also reliable polycentricity indicators on regional as well as supra-national level would be necessary. From the SSGI side, a combination of input- and output-indicators could further enhance the models (Marques da Costa et al., 2013). As this study has shown, single SSGI indicators of various characters cannot fully unfold the potential impact of polycentricity. Further studies should e.g. include number of kindergartens and number of universities and relate them to the respective output indicators (number of children/students) or, similarly, number of treated patients should be related to number of hospital beds. A future hypothesis could then be if polycentricity is maybe not creating more SSGI (in terms of output) but enables a more efficient production of SSGI (in terms of less facilities needed to accomplish a certain number of output).

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