Polycentric Europe: more Efficient, more Equitable and more Sustainable?

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Abstract

The idea of a balanced polycentric urban system plays a prominent role in major strategic documents on European spatial planning. However, it remains a promise without sound empirical evidence how much the implementation of this idea would serve the major goals of the European Union competitiveness, cohesion and sustainability. This paper is to contribute to the understanding of polycentricity by reviewing different definitions and methods to measure and forecast polycentricity and to assess the impacts of different levels of polycentricity on economic growth and territorial cohesion. The conclusion is that polycentricity could be a rational trade-off between the conflicting goals growth and equity, but that more research is needed to forecast the likely impacts of combinations of different time-sequenced sectoral policies to achieve that trade-off.

Keywords: European Spatial Planning, Polycentricity, Territorial Cohesion

1. Introduction

Since the European Spatial Development Perspective (ESDP, 1999), the promotion of polycentricity, i.e. 'a balanced polycentric urban system', is one of the most frequently cited policy objectives of the spatial policy of the European Union.

In principle two policy options for influencing the settlement structure of the European territory are discussed:

- Strengthening of several larger *zones of global economic integration* in the EU, equipped with high-quality, global functions and services, including the peripheral areas, through transnational spatial development strategies.
- Strengthening a *polycentric and more balanced system of metropolitan regions, city clusters and city networks* through closer co-operation between structural policy and other sectoral policies, such as transport and innovation policy.

It is hoped that by encouraging secondary urban regions, the competitive potential of these regions will improve and that 'dynamic global integration zones' can be formed beyond the 'pentagon' defined by the London, Paris, Milan, Munich and Hamburg.

The interest in polycentric development is fuelled by the hypothesis put forward in the ESDP that polycentric urban systems are more efficient, more sustainable and more equitable than both monocentric urban systems and dispersed small settlements.

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The concept of polycentricity of settlement structures originated as an *empirical* concept in the 1930s. Central-place theory explained hierarchical decentralisation of cities by the fact that different goods and services command service areas (Christaller, 1933) and market areas (Lösch, 1940) of different size. A contrasting view was proposed by polarisation theory which pointed out that increasing economies of scale lead to growing concentration in only few large cities (Perroux, 1955; Myrdal, 1957). Both perspectives are integrated in the results of economic geography (Krugman, 1991; Fujita et al.,1999) which show that different constellations of economies of scale and spatial interaction costs lead to different spatial arrangements of production and consumption. One important contribution of these approaches is that not only vertical linkages are important but also horizontal linkages between cities with complementary economic specialisation.

Polycentricity as a *normative* concept can be traced back to the concept of self-contained satellite towns connected to the central city by commuter railways promoted by the garden city movement (Howard, 1902). In the 1940s the Nazis applied Christaller's central-place theory to the occupied territories in Poland recognising that a hierarchical network of central places can also be used for military control:

> "The final domination of the Generalgouvernement will be based on the key positions of a regular network of central places. The central place in the Generalgouvernement, centre and leader of its region and focus of German culture, power and economy, will contain all elements required for the immediate expression of German dominance."
>
> (Schepers, 1942)

Despite this ambiguity of the concept, many countries adopted central-place concepts as principle for guiding their spatial development after World War II. The hypothesis was that central-place systems are both efficient (in terms of economies of scale) and equitable (in terms of equivalent living conditions).

It can in fact be argued that both extremes, *monocentricity* (all activities are concentrated in one centre) and *dispersion* (all activities are equally distributed over space) perform poorly with respect to the policy goals efficiency, equity and sustainability:

- *Efficiency*. Large centres can exploit economies of scale and agglomeration effects but suffer from negative effects of over-agglomeration. Dispersed settlements enjoy nature but are too small to support efficient infrastructure facilities and units of production.
- *Equity*. Spatial polarisation is built on competition and so leads to spatial segregation between rich and poor, central and peripheral cities. Spatial dispersal is egalitarian in its distribution of poverty but denies its citizens opportunities for social mobility.
- *Sustainability*. Large settlements use less energy for transport but more for high-rise buildings, air-conditioning and waste management. Dispersed settlements can utilise local renewable resources but are wasteful in terms of transport energy and open space.

It is obvious that the optimum lies somewhere in between monocentricity and dispersal, i.e. in a balanced mixture of large, medium-sized and small cities arranged in a pattern favourable for exchange and co-operation.

This view was expressed by the 'bunch-of-grapes' metaphor proposed by Kunzmann (Kunzmann and Wegener, 1991) as a different and more 'co-operative' *Leitbild* for urban development in Europe than the 'Blue Banana' proposed by French geographers (RECLUS, 1989), which was viewed as "the pure expression of the competition between the regions in Europe". The authors claimed that the bunch of grapes was more suited to represent the polycentric structure of the urban system in Europe and the fundamental *similarity in diversity* of the interests and concerns of its member cities (see Figure 1):

Figure 1 – The bunch of grapes (Kunzmann , 1991)

Inspired by the long history of multiple small states in medieval Germany and the tradition of central-place theory in German regional science, during the German EU presidency in 1999, German regional scientists were successful in proposing polycentricity as the guiding principle of the European Spatial Development Perspective (ESDP, 1999) and re-articulating it again under German presidency in 2007 in the Territorial Agenda (TA, 2007). However, until today the concept of polycentricity has remained largely at the level of rhetoric without a precise operational definition (which puts it into a class with similarly vague concepts such as 'city networks' or 'industrial clusters'). There exist several competing methods to *identify* or *measure* polycentricity at different spatial scales and to *assess* the impacts of polycentricity (or the lack of it) with respect to policy goals such as competitiveness, cohesion and sustainability. It is therefore presently not possible to determine an *optimal* degree of polycentricity between centralisation and decentralisation or, in other words, between the extremes of monocentricity and dispersal. This makes it difficult to formulate well-founded policy recommendations as to which cities should be developed with priority.

It is the goal of this paper to contribute to the understanding of polycentricity by reviewing different definitions and methods to measure polycentricity and, based on one of them, to assess the impacts of different levels of polycentricity with respect to the major goals of the European Union, competitiveness, cohesion and sustainability. The review will be based on the results of ESPON projects ESPON 1.1.1 (Urban Areas as Nodes in Polycentric Development) and ESPON 1.1.3 (Enlargement of the European Union and its Polycentric Spatial Structure) and a recent update in ESPON ET2050 (Territorial Scenarios and Visions for Europe) taking account of the effects of the economic crisis.

2. Measuring Polycentricity

All attempts to define polycentricity start with typologies. The most influential typology of urban areas in Europe is the one of ESPON 1.1.1 (2004). In ESPON 1.1.1 urban areas in Europe were analysed at three spatial levels: at the European level, at the national level and at

the regional and local level. As units of analysis, 'functional urban areas' (FUAs) were defined in each country. Of these, urban centres to be included in the analysis were selected using seven criteria: population, transport (airports, ports), tourism (hotels), industry (gross value added), knowledge (universities), corporate decision making (headquarters) and administrative functions. The selected centres were classified using a typology of global, European, national, regional and local importance. In addition, accessibility and other indicators were collected and presented for the selected centres.

In a parallel approach CNRS-UMR analysed polycentricity based on the relational logic of territories ("the space of flows") proposed by Castells (1989). The study (CPMR, 2002) proposed a typology of urban areas based on competitiveness (GDP per capita, labour productivity), economic decision-making (number of headquarters of the top 1500 European firms), human capital (share of R&D employment, share of population 25-59 years of age with higher education), connectivity (number of international flights and destinations) and 'drivers of change' (growth of GDP and productivity).

The Draft Guidance Paper prepared by ESPON 3.1 (2003) proposed a three-level hierarchy of urban areas: the *macro* level (European core, European periphery, accession countries and neighbouring countries), the *meso* level (metropolitan areas, urbanised areas and non-urban areas) and the micro level (metropolitan areas, cities, towns and villages). It proposed that each NUTS-5 region be classified by its membership in the macro, meso and micro categories and that each NUTS-3 regions be assigned to one meso level group based on the characterisation of its NUTS-5 members.

These classifications of urban areas are useful but do not yet provide a measurement of polycentricity, and they neglect the *spatial* dimension, i.e. the distance between centres at the same level of the urban hierarchy and between centres at one level and those at lower and higher levels as well as the functional relations between centres of the same or different levels. Therefore in ESPON 1.1.1 a method to measure both *morphological* aspects (hierarchy, distribution, number of cities) and *relational* aspects (flows and co-operations between urban areas at different scales) by three dimensions was proposed:

- *Size*. The first and most straightforward prerequisite of polycentricity is that there is a distribution of large and small cities. It can be postulated normatively that the ideal rank-size distribution in a territory is loglinear. Figures 2 and 3 show the rank-size distribution of population and gross domestic product (GDP), respectively, of cities in Italy. It can be seen that in terms of population Rome is leading, whereas in economic terms Milan is the dominant city.

- *Location*. The second prerequisite of a polycentric urban system is that its centres of equal size or rank are equally spaced from each other – this prerequisite is derived from the optimal size of the catchment area or market area of centrally provided goods and services. Therefore, a uniform distribution of cities across a territory is more appropriate for a polycentric urban system than a highly polarised one where all major cities are clustered in one part of the territory. Figure 4 shows the subdivision so derived for Italy.

- *Connectivity.* A third property of polycentric urban systems is that there is functional division of labour between cities, both between the higher-level and lower-level centres in their territory and between cities at equal levels in the urban hierarchy. This implies that also lower-level cities are well connected. Figure 5 shows that this is the case in Italy as shown by the relatively low correlation between population size and accessibility of the Italian cities and the relatively low Gini coefficient of accessibility of cities.

Figure 2. Rank-size distribution of population of cities in Italy (ESPON 1.1.1)

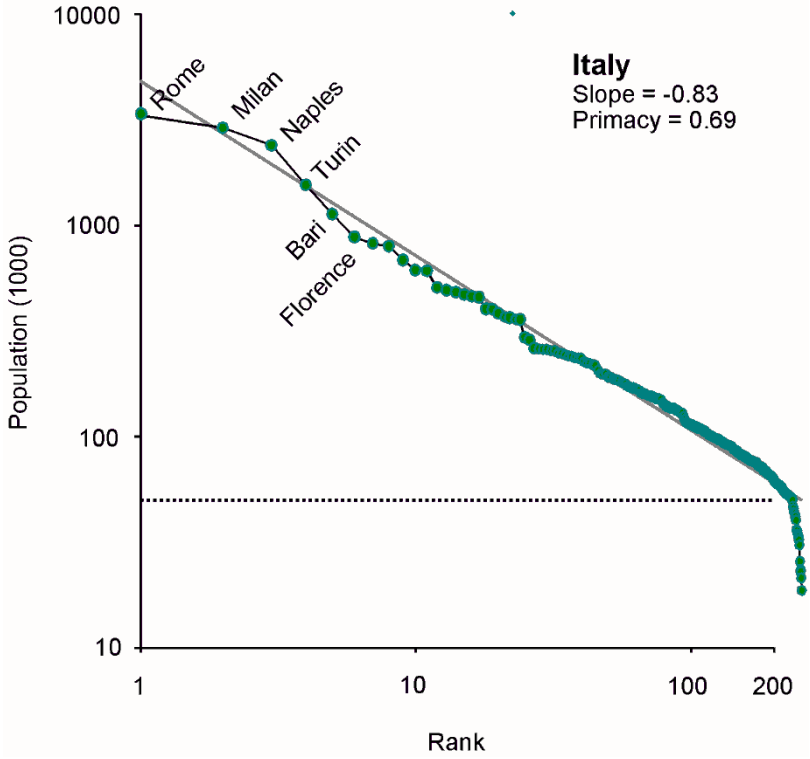


Figure 3. Rank-size distribution of GDP of cities in Italy (ESPON 1.1.1)

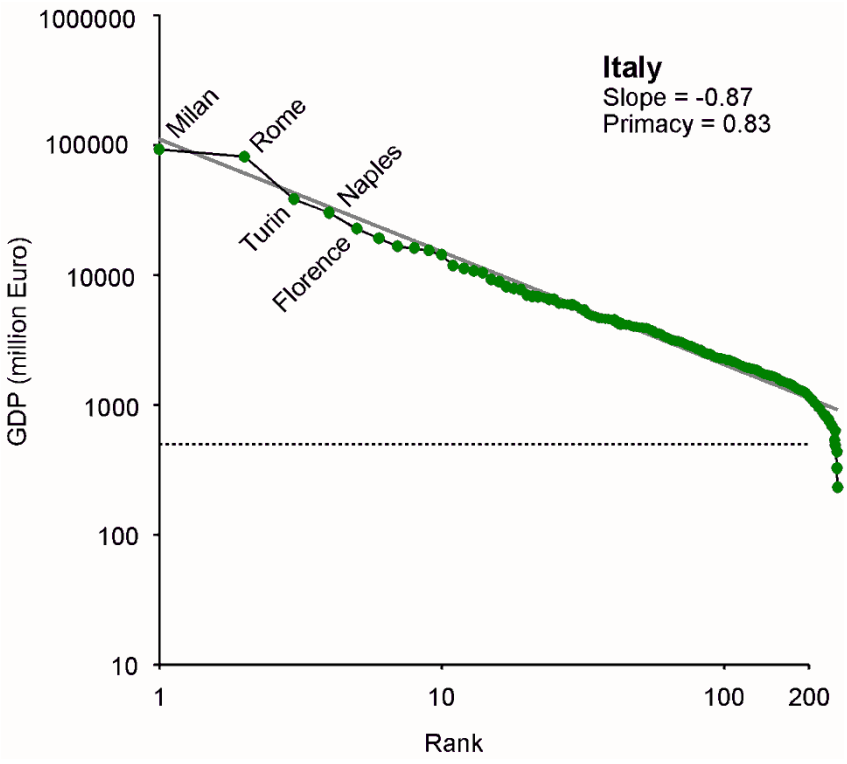


Figure 4. Service areas of cities in Italy (ESPON 1.1.1)

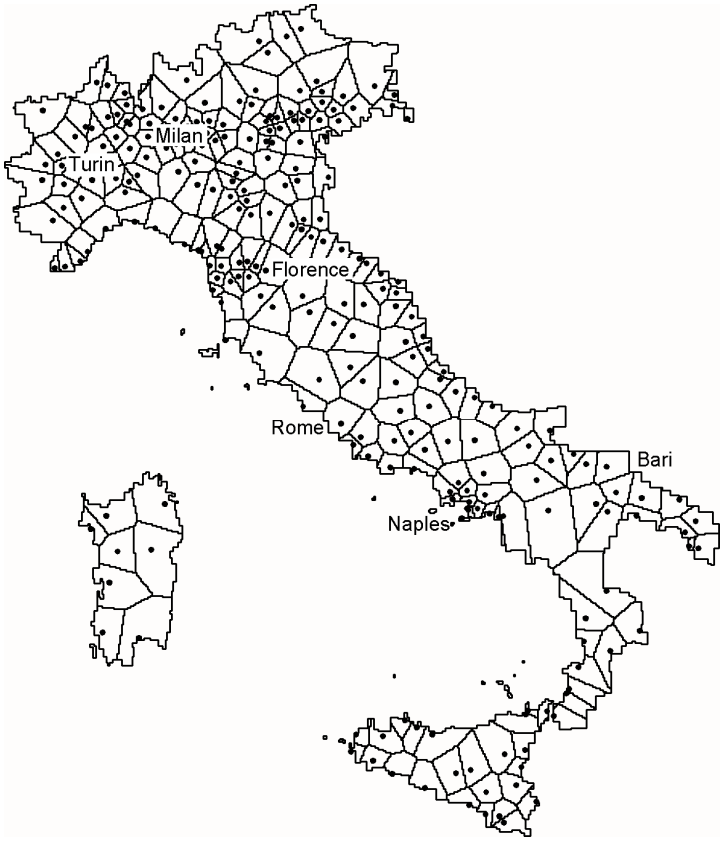
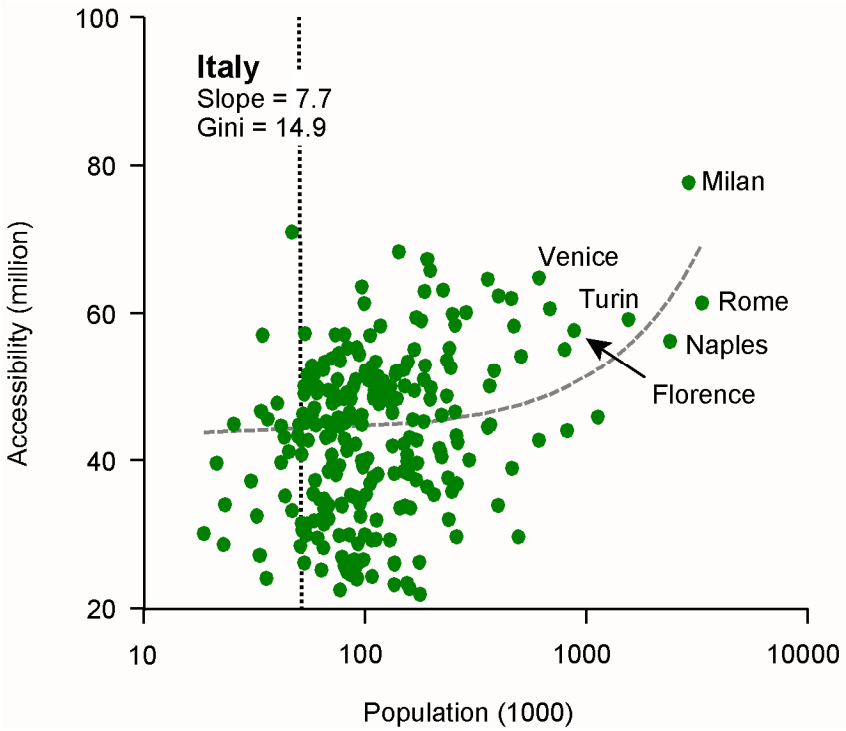


Figure 5. Correlation of population and accessibility of cities in Italy (ESPON 1.1.1)



With the three components of polycentricity, size, location and connectivity, a comprehensive index of polycentricity was constructed. For each sub-indicator a z-shaped value function was defined. Table 1 shows the threshold values defined for the seven sub-indicators:

Table 1. Value functions of polycentricity sub-indicators

	Rank-size distribution of population		Rank-size distribution of GDP		Size of service areas	Correlation of population and accessibility	
	Slope	Primacy	Slope	Primacy	Gini	Slope	Gini
Indicator value at which polycentricity is 0	–1.75	7.5	–1.75	10	70	75	25
Indicator value at which polycentricity is 100	–0.5	0	–0.5	0	10	0	0

Table 2 shows the weights for the composition of the polycentricity index from the three components. Additive aggregation was used at the lower levels, whereas the three component indices were aggregated to the polycentricity index multiplicatively.

Table 2. Composition of the polycentricity index

Index	Indicator	Weights	Weights
Size	Slope of regression line of population Primacy rate of population Slope of regression line of GDP Primacy rate of GDP	10% 40% 10% 40%	33%
Location	Gini coefficient of service areas	100%	33%
Connectivity	Slope of regression line of accessibility Gini coefficient of accessibility	50% 50%	33%

This polycentricity index was criticised in ESPON 1.4.3 (2007) by Vandermotten et al. (2007) because they felt that it overemphasises the spatial distribution of cities. However, the polycentricity index they proposed instead remains purely morphological and ignores both the service functions of cities and the relational dimension of polycentricity.

Figure 6 shows the ESPON 1.1.1 polycentricity index for European countries. Slovenia, Ireland, Poland and Denmark are the most polycentric countries, but for different reasons. Slovenia benefits from its high scores in all three dimensions. Ireland takes advantage of the balanced distribution of FUAs over its territory despite the clear primacy of Dublin. Poland scores high because of its balanced size distribution of cities and their equal distribution over its territory. Italy scores in the middle range despite its balanced distribution of city sizes but the relatively large differences in the service areas of cities.

Figure 7 shows the results of the same analysis for NUTS-1 regions. As to be expected, smaller regions are more homogenous and therefore tend to score higher in polycentricity. Italy has regions with different levels of polycentricity. Whereas northern Italy has relatively polycentric urban systems with equally spaced cities, central Italy is dominated by few large cities. A special case is the Nord-Est region including not only the highly urbanised Veneto but also Trentino-Alto Adige and Friuli-Venezia-Giulia with large rural areas. If Veneto alone would be considered, its polycentricity would probably score higher.

Figure 6. Polycentricity index of countries (ESPON 1.1.1)

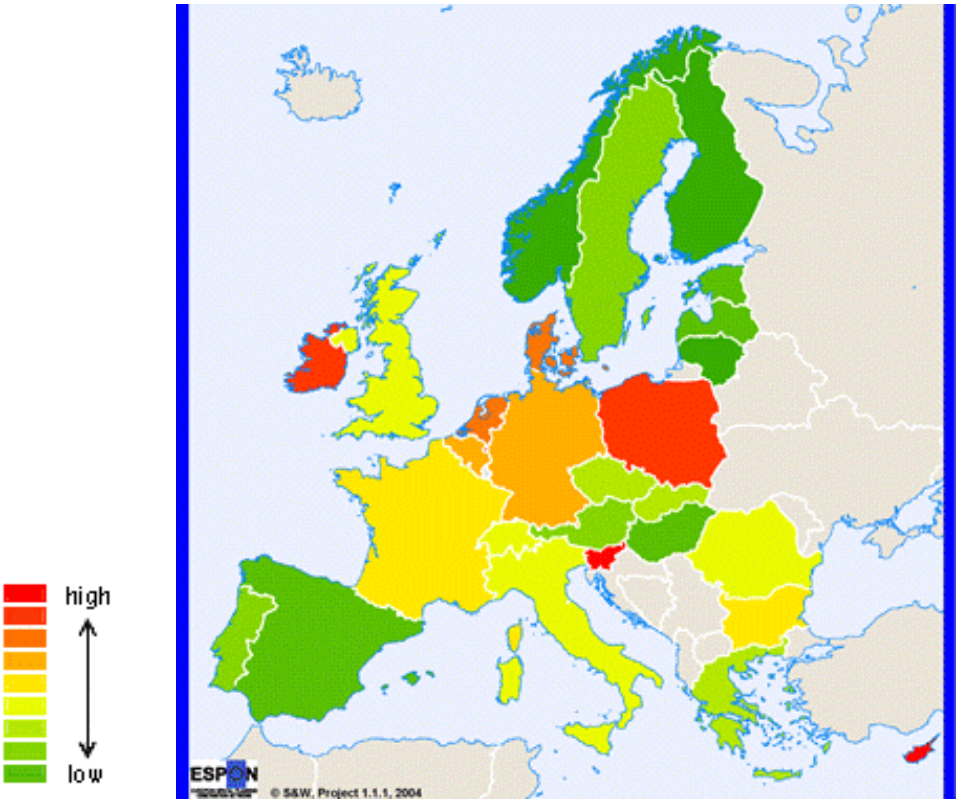
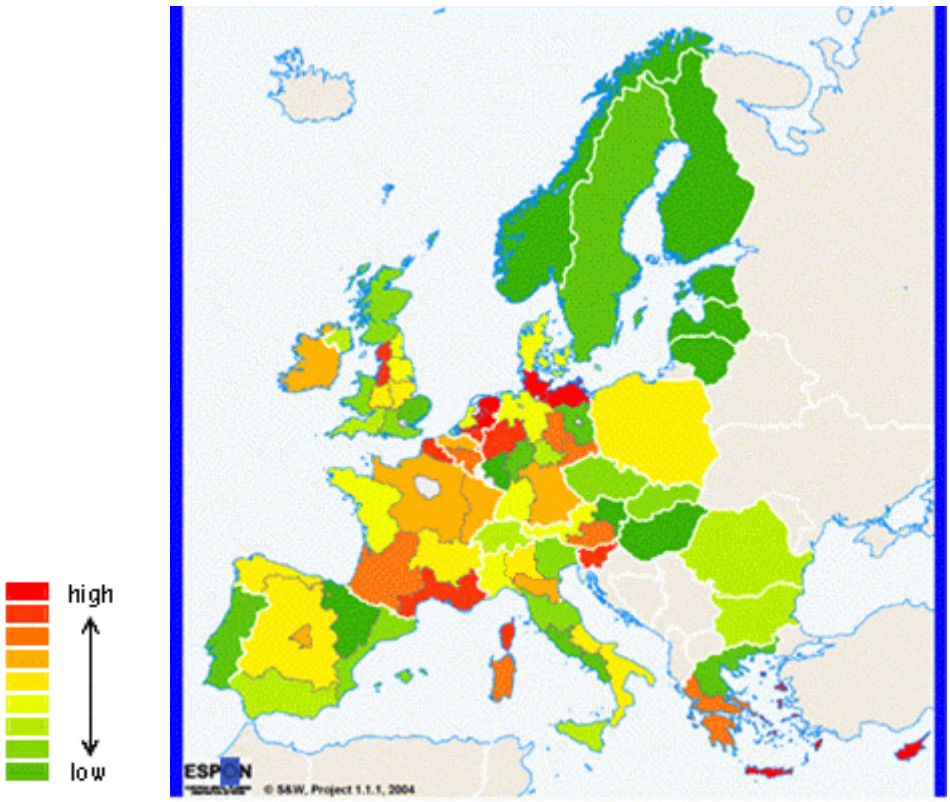


Figure 7. Polycentricity index of NUTS-1 regions (ESPON 1.1.1)



3. Forecasting Polycentricity

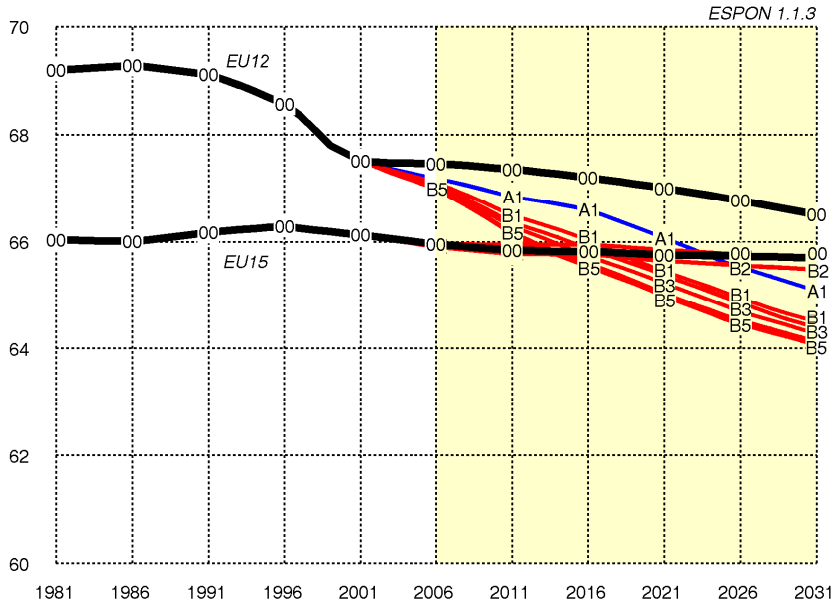
The ESPON 1.1.1 polycentricity index was used in ESPON 1.1.3 (2006) to analyse, forecast and compare the development of polycentricity over time in the old EU member states (EU15) and the new member states that joined the EU in 2004 and 2007 (EU12).

For this the SASI regional economic model was used. The SASI model is a recursive simulation model of socio-economic development of regions in Europe subject to exogenous assumptions about the economic and demographic development of Europe as a whole and transport and other policies (Wegener and Bökemann, 1998). The SASI model differs from other approaches to model the impacts of transport on regional development by modelling not only production (the demand side of regional labour markets) but also population (the supply side of regional labour markets). A detailed description of the SASI model is contained in Wegener (2008).

In ESPON 1.1.3 polycentricity was analysed at three spatial levels, European, national and regional. Here only the results at the national level are discussed. Figure 8 shows the modelled development of national polycentricity in the old EU member states (EU15) and the new EU member states (EU12) between 1981 and 2031. The heavy black line represents the baseline Scenario 00 without EU enlargement. Scenario A1 is the enlargement scenario. The five B scenarios are variations of the enlargement scenario differing by the speed and direction of European transport infrastructure projects.

The diagram reveals the striking difference between the old and new member states. While the spatial structure of the urban systems in the old member states is relatively stable and hardly affected by the transport investments, the new member states after the economic transition of 1990 underwent a concentration of population and economic development in their capital cities with the effect that their original high levels of polycentricity rapidly declined. This development was accelerated by the intensive upgrading of their transport infrastructure supported by EU funding.

Figure 8. National polycentricity in old and new member states 1981-2031(ESPON 1.1.3)



A similar picture emerges when the same analysis is performed with more recent data taking the economic crisis of 2008 into account. Figures 9 and 10 show first results of scenario simulations performed in ESPON ET2050. Again the heavy black line represents the baseline Scenario 00. The other three scenarios are exploratory scenarios examining basic alternatives of spatial policy: Scenario A0 assumes focusing of all subsidies and transport policies on the largest metropolitan areas in Europe defined in ESPON 1.1.1 in the interest of competitiveness. Scenario B0 assumes concentration of spatial policies on the second-tier of cities in Europe, and Scenario C0 continuation of current Cohesion policies directed at the least advantaged rural and peripheral regions (ESPON ET2050, 2013, 13).

Figure 9. Polycentricity of old member states 1981-2051(ESPON ET2050)

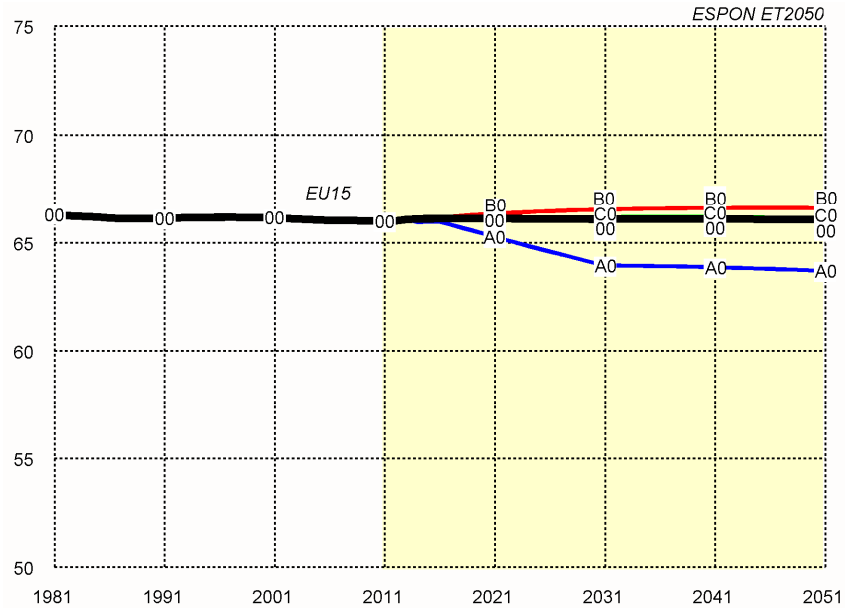
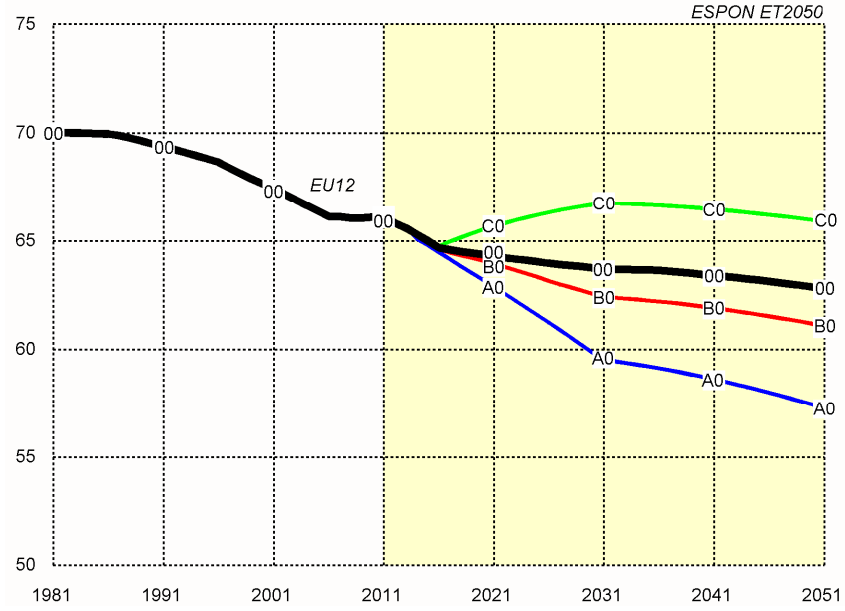


Figure 10. Polycentricity of new member states 1981-2051(ESPON ET2050)



These results show that the economic crisis has briefly interrupted but not fundamentally changed the general pattern of spatial development in Europe and is not likely to do so in the future unless new major turbulences jeopardise economic recovery. However, the policy alternatives assessed in the three exploratory scenarios may eventually decide whether the goal of a balanced polycentric urban system in Europe will be achieved. In particular it is apparent that the competitiveness-oriented Scenario A0 will go at the expense of cities at the lower levels of the urban hierarchy, and that only a radical enforcement of Cohesion policy will prevent a further decline of polycentricity in the new member states.

4. Evaluating Polycentricity

Polycentricity is not a goal by itself but is propagated as a means to achieve a more balanced and more equitable spatial structure. However, despite its prominent role in two major policy documents on the future of the European territory, the European Spatial Development Perspective and the Territorial Agenda, the benefits of polycentricity in terms of economic welfare, social and spatial equity and environmental sustainability are still not more than a promise without sound empirical evidence. It is therefore important to critically examine the likely impacts of further promotion of cities at the lower levels of the urban hierarchy versus the promotion of but the largest metropolitan areas.

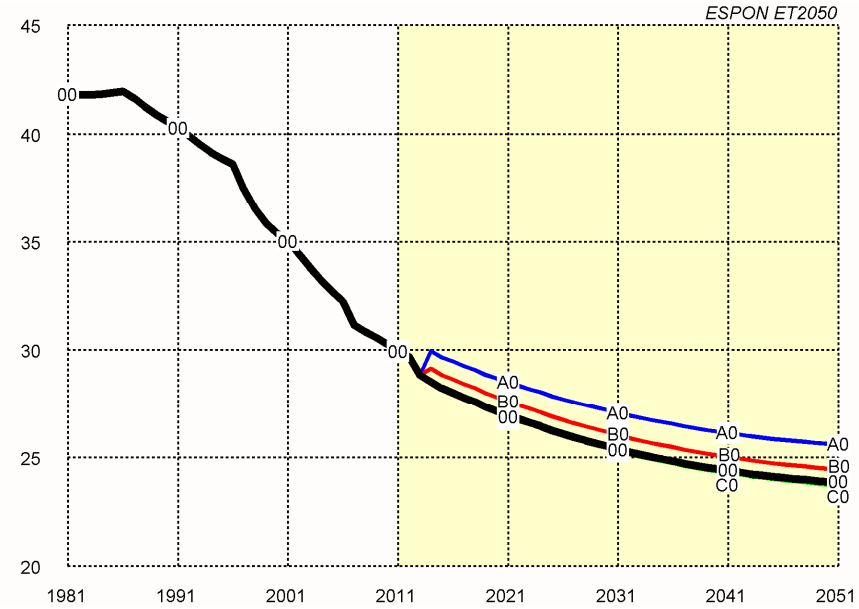
There are a few attempts to assess the impacts of polycentricity on economic growth, territorial cohesion and environmental sustainability. A first attempt was made in ESPON 1.1.1 to test whether more polycentric countries in Europe are economically more successful, more equitable and more sustainable than monocentric countries (ESPON 1.1.1, 2004). The results seemed to confirm the hypothesis that countries with a more polycentric spatial structure are economically more successful than monocentric countries, if the more affluent old member states are considered separately from the much poorer new member states. However, Vandermotten et al. analysing not levels of GDP per capita but growth of GDP per capita over time came to the opposite conclusion, that more monocentric regions are more successful, with correlation coefficients between 0.3 and 0.52 (Vandermotten et al, 2007, 56-58).

The situation is more complex with respect to equity. The results of ESPON 1.1.1 showed that in the new member states the correlation between polycentricity and equity, expressed as Gini coefficient of regional GDP per capita, is almost zero whereas in the old member states there is even a negative correlation between polycentricity and spatial equity.

In terms of environmental sustainability, total energy consumption for transport (in oil equivalent) was taken as indicator of environmental sustainability. In order to neutralise the effect of income differences between countries, energy consumption per unit of GDP was used. With this indicator, there is a clear correlation between polycentricity and energy consumption: more polycentric countries use less energy for transport per unit of GDP than monocentric countries, and this holds for both old and new member states.

Besides comparing measures of polycentricity with observed data it is possible to associate model outputs of polycentricity and variables of interest, though of course not as empirical proof but as aid in formulating hypotheses.. This is currently being done in ESPON ET2050. Figure 11 shows the Gini coefficient of GDP per capita in all NUTS-3 regions of the ESPON Space and the Western Balkan countries between 1981 and 2051 as predicted by the SASI model. It can be seen that territorial cohesion increases significantly after the economic transition of the 1990s and continues, though more slowly after the recent economic crisis. It is also apparent that the promotion of large metropolitan areas in Scenario A0 and of major European cities in Scenario B0 has negative impacts on territorial cohesion.

Figure 11. Gini index of GDP per capita of NUTS-3 regions 1981-2051 (ESPON ET2050)



5. Conclusions

This paper critically examined the history and theoretical background of polycentricity, the methods for measuring and forecasting polycentricity and the contribution of polycentricity to the achievement of political goals of the European Union, competitiveness, territorial cohesion and sustainability.

Originating in central-place theory of the 1930s, the concept of a balanced polycentric urban system was introduced into the discussion about the spatial future of Europe during the German EU presidencies of 1999 and 2007. From a theoretical point of view, the multi-layer system of urban centres of different functionality and catchment areas associated with polycentricity should ideally deliver (i) the agglomeration effects needed for economic growth, (ii) the equitable distribution of services of general interest and (iii) all that with a minimum of spatial interaction effort.

In the debate about the most appropriate definition and measurement of polycentricity two positions can be distinguished: comprehensive approaches which include aspects of size, location and connectivity in the definition of polycentricity and purely morphological approaches focusing on the agglomeration effects cities and ignoring their service functions and the interactions between them.

Despite its prominent role in the two most prominent documents on European spatial planning, the state of knowledge about the contribution of polycentricity towards the achievement of the major goals of the European Union is still limited. There is wide-spread agreement that the promotion of the largest metropolitan areas at the expense of the secondary cities is likely to generate maximum growth because of their global connectedness, agglomeration effects and highest productivity, but that such a policy would increase economic disparities between the regions in Europe. There is also agreement that giving priority to assisting rural and peripheral regions in their development, in particular regions in the new member states, would reduce economic disparities in Europe but result in lower total economic growth. But there is little agreement on how the two policy orientations could be combined.

The results of the various ESPON projects referred to suggest that a polycentricity strategy, i.e. the promotion of a multi-level system of cities of different size, service functions and interactions, could be a rational trade-off between the conflicting goals of growth and equity.

The impacts of such a strategy on sustainability in terms of energy conservation and greenhouse gas reductions are still largely unknown. One hypothesis is that if only energy conservation is the objective, high-density monocentric settlement structures are the winners but that if also other aspects of sustainability, such as air ventilation and access to open space, are included, medium-density, mixed-use polycentric settlement structures may be better. What can be said with certainty is, however, that settlement structures are not the most important factor for sustainability compared with other drivers, such as energy efficiency, energy costs and, most importantly, behavioural change. The final result could be that polycentric structures have an important enabling function being more suited for sustainable life styles and mobility patterns than concentrated or dispersed spatial organisations.

From a policy point of view the main postulate would be to increase the knowledge about the likely impacts of policy packages or combinations of different sectoral policies on spatial development and hence economic development, social and territorial equity and sustainability. Such policy packages should be time-sequenced (ARL, 2004). For instance, it may be necessary to continue for a limited time the promotion of the capital cities of the new member states to help them as quickly as possible to develop their economies, but that in the long run also these countries should be encouraged to develop their medium-sized and smaller cities towards a balanced polycentric urban system.

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