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# Editorials

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# Editorial: Regional Science debates take place in REGION

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Scientific debates involve academic discussions associated with topics, techniques, and even societal aspirations. Still, scientists are also concerned with the management of science. New institutional demands and opportunities enable scientists to better manage the ways in which outputs are produced and disseminated. REGION is indeed a clear example of academic answers to such new challenges and trends.

Parallel discussions and changes are also taking place in academic institutions. In 1954 Walter Isard founded the Regional Science Association. Over time the Association has changed and nowadays the organizational structure serves as an umbrella organization overseeing superregional organizations, including the European one, ERSA, which likewise, covers 19 sections.

Regional science is not only an academic discipline. Practitioners and policy makers are also involved at conferences and workshops. Meetings, such as the upcoming 2016 ERSA Congress in Vienna, are an imperative ingredient to the assignments of researchers and policy makers alike. As Borghans et al. (2010, p. 868) point out, conferences "provide the possibility to acquire feedback on a paper, to get informed about the work of others, and to talk to colleagues to exchange ideas. A relaxed atmosphere and being away from the office can promote creativity".

Nevertheless, discussions are not only taking place in shared physical spaces. They are also occurring in the literature, particularly in journals, newsletters and in electronic media. In our first Editorial we briefly reviewed several historical papers addressing the state of the art of Regional Science as a discipline. The third volume of REGION picks up the baton and presents a Manifesto proposing the creation of a new think-tank platform – the Regional Science Academy. We are proud to publish such an outcome, for it presents REGION as an environment that houses and promotes such discourse. In this line, we will be pleased to publish reactions to the Manifesto in the future.

The journal is in excellent shape, with several Special Issues in preparation, receiving high quality submissions and waiting for new ones. We take this opportunity to thank Roberto Patuelli for his excellent service to REGION as Managing Editor in the last two years. He took over the responsibility and difficult mission of launching a new journal. The Editorial Team in an optic of shared responsibility continues this task, pursuing with haste the inclusion of this journal in to the most prestigious indexing platforms. We are proud of our journal and want the world to know that Regional Science now has an open-access publication with the highest standards for quality.

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# Articles

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# Social Capital and Economic Well-being in Germany's Regions: An Exploratory Spatial Data Analysis

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**Abstract.** This article explores social capital in Germany in line with Putnam's claim that social capital benefits regional economic well-being. In particular, this macro-level study examines whether the number of civic associations, as a measure of a vibrant civil society, is related to higher GDP. Since this study uses spatial data on civic associations and official statistics concerning the German NUTS-3 regions, different spatial matrices model interdependencies among the dependent units of analysis. Exploratory spatial data analysis illustrates spatial patterns between districts, as well as each variable's radius of influence. Cross-sectional spatial models help examine social capital's effect on regional economic well-being. Results of these analyses are two-fold: first, the geographical scope of social capital is locally concentrated, whereas the sphere of economic well-being encloses a wider area. Second, social capital correlates positively with economic well-being in Germany's many regions.

**Key words:** social capital, civic associations, economic well-being, Germany, spatial interdependence

## 1 Introduction

Social capital is one of social science's top exported concepts due to its easy transfer to and from daily life. Moreover, social capital is appealing to diverse research strategies and approaches because it is a multidimensional medley measured with different indicators, analysed with respect to different outcomes, and studied on different levels of analysis. Over the course of the last 25 years, social capital has become a widely used synonym for social contacts, networks, norms, and trust. This is based primarily on Putnam's (1993, 2000) definition, who describes social capital as "features of social life – networks, norms, and trust – that enable participants to act together more effectively" (Putnam 1993, p. 664). Putnam emphasised "networks of civic engagement, like neighbourhood associations, choral societies, cooperatives, sports clubs, mass-based-parties [... as the] essential form of social capital" (Putnam 1993, p. 173). Members and even non-members can benefit from dense civic networks. For Putnam it is clear that "civic connections help make us healthy, wealthy, and wise" (Putnam 2000, p. 287), and that social capital in general is associated with a variety of individual and collective benefits. On a contextual level, communities and regions with dense social networks can be more productive, collaborate successfully, and perform more optimally.

Social scientists claim that social capital is an explanatory factor for prosperity; this highlights a social dimension in the economists' perspective on wealth, and leads to a routinisation of social capital in economic development research (Woolcock 2010). Putnam (1993, 2000) tested his hypothesis that social capital enhances socio-economic well-being by analysing American and Italian regions. His maps have become quite well-known, which show differences of social capital indices across American states and Italian regions. Many social capital researchers followed this line of thought by analysing macro-units such as cities, states, regions, or countries, but their statistical analyses often neglect spatial dependence on units of analysis, with the result that the standard errors of the regression's coefficients are underestimated. This means substantive interpretations may be misleading. The general principal that proximal regions are more intimately related, similar to each other, and are able to perform more successfully than more distant areas, should be transferable to social capital research as well. Regional embeddedness and proximity are substantial determinants for vibrant networks and face-to-face contacts, and therefore important for social capital (see section 2.3). However, research has thus far neglected spatial patterns and scopes of social capital. Indeed, this article addresses this neglect in delving into whether there are spatial interdependencies of social capital among macro-units and whether they are significant in explaining prosperity. Inspired by Putnam's studies, this article investigates the relationship between economic well-being and social capital, specifically among subnational regions in Germany as the units of analysis. This work contributes to the literature by introducing unique data from an organisational census of civic associations, which are a structural indicator for social capital. Consequently, it conducts explorations of spatial patterns of regional social capital in Germany and examinations of its scopes for the first time. Lastly, it employs spatial regression models toward analysing social capital's relation to wealth, and simultaneously capturing spatial dependence among German regions.

The outline of the paper is as follows. The second section discusses the relationship of social capital and economic well-being as well as the spatial dimension of both variables. The third part introduces data on Germany's subnational regions. Section four describes the spatial patterns of economic well-being and social capital, appropriating them to discuss how spatial interdependence in Germany can be modelled. Section five exhibits diagnostic tests so as to detect spatial patterns; in particular, it applies local indicators and global measures of spatial association. The sixth section presents spatial regression models to analyse economic and social determinants of regional well-being and capture spatial correlations in the data. Moreover, it discusses limitations, and outlines avenues for further research, finally arriving upon a conclusion.

## 2 Social capital and economic well-being

Several features affect prosperity: structural factors such as infrastructure, transportation systems, or population structure; institutional factors like policies or governmental interventions; economic factors like capital, trade volume, or labour force (Acemoglu 2009, Barro, Sala-i Martin 2004, Kaldor 1957); additionally, social features such as individual human capital contribute to aggregate wealth (Barro 2001, Mankiw et al. 1992, Mincer 1984). Furthermore, social scientists are interested as to whether social relations affect wealth; social capital has proven to be a useful concept in the study of societal well-being (Newton 2001, Putnam, Helliwell 2004). Putnam (1993, 2000) argued in his seminal books that the more vital civil society, the better off the regional economy. He showed that a strong civil society, represented by the number of civic associations, is strongly related to both a prosperous economy and a working democracy.

### *2.1 The magical relationship between social capital and economic well-being*

Putnam explained the relationship between civic associations and prosperity with "the magic of social capital" (Putnam 2000, p. 288). Generally speaking, networks of civic associations facilitate communication and coordination; they create an atmosphere of trust, enforce reputation, and can thereby solve dilemmas of collective action. Following rational choice theory, members of civic associations learn to cooperate and collaborate

through regular meetings and durable networks because the opportunity for social control is high, and the incentives to defect are low (see Axelrod 2006). The "shadows of the future and of the past" are essential incentives that form a foundation for cooperation. Moreover, regular group interactions instil pro-social norms, habits of solidarity, and a feeling of common identity since the needs of the individual are subsumed under collective benefits (Almond, Verba 1963, Putnam 1993). These are side-effects of associational activities. Besides the basic functions associations permit such as playing baseball, singing in choral societies, or advocating for the deprived, social engagement makes them more trusting and better citizens. Such indirect effects of civic associations affect (more or less) all participants. Moreover, civic associations can directly support local economies, enlarge participants' social networks and encourage networking between economic actors. Civic associations consume goods and services through their daily routine and thereby stimulate the economy. More than anything, they build trust and therefore responsibility in local economies. Even non-participants in some way related to those in the associations' network, could directly or indirectly have access to its resources and contacts, learn social norms it promotes, and experience as well as carry on mutual trust. This is a process of diffusion using a transfer of trust, norms, and resources from the associational network into other parts of society – both private and public; this is a spillover effect of social capital. Putnam (2000, pp. 319-325) generalized this argumentation, and assumed that neighbourhoods, states and even nations benefit from their citizens' social capital.[1]

### *2.2 Empirical studies on social capital and economic well-being*

Inspired by Putnam's assumption, researchers from different fields have analysed the impact of social capital on economic performance within and across spatial units. With the focus on the macro-level,[2] Algan, Cahuc (2013) reviewed the international and interregional heterogeneity of trust as a measure of social capital, and found a strong relationship between trust and growth. Using an index of social capital, Doh, McNeely (2012) confirmed that social capital drives economic development in at least 47 countries. Regardless, aggregate economic well-being is composed of smaller spatial units' performance; economic models for the state level, for instance, have to be translated into regional argumentation. Capello, Fratesi (2012) presented a newer version of their regional growth model. In line with Putnam's tradition, they showed that regions exhibiting higher social capital cooperate better and grow faster. In related research, Fazio, Lavecchia (2013) found spatial heterogeneity in trust across European regions. They concluded that disaggregation at regional levels reveals information that remains elusive at the national level (Fazio, Lavecchia 2013, p. 315). In line with this conclusion, Iyer et al. (2005) suggested a shift towards a more region-specific approach to social capital.

According to the literature, social capital helps explain the success of regions: dense networks and embeddedness promote innovation and economic collaboration (Malecki 2012, Rutten, Boekema 2007). De Dominicis et al. (2013) studied the relationship of social capital and regional economic performance among 146 NUTS-2 regions across countries in Europe. Their spatial analyses showed that proximity and social capital matter for creating new knowledge and innovation. Similarly, Westlund, Adam (2010) analysed social capital and economic performance with a meta-analysis of 65 studies since 1995 at different spatial levels. 23 papers dealt with national analyses, 7 with regions over several countries, and 14 analyses concentrated on regions in one country.[3] Most works use different social capital indicators like trust, membership, or indices. Only two

[1] In contrast, social capital is not positively linked to wealth by implication. The fact that interest groups and groups that share distrust rather than mutual trust and acceptance are subsumed under the "dark side of social capital" (Graeff 2009, Graeff, Svendsen 2013, Putnam 2000).

[2] As a matter of course, social capital affects economic well-being on the micro- and meso-level as well. An enormous body of research literature can be found at the individual level which, for instance, analyses how social capital improves employment situations (Franzen, Hangartner 2006, Granovetter 1995, Mouw 2003, Obukhova, Lan 2013, Thompson 2005) or related economic outcomes (Boxman et al. 1991, Gerber, Mayorova 2010, Kwon et al. 2013, Lancee 2010, 2012). Furthermore, Lee (2009) stated for the meso-level that "social capital is potentially an important source of competitive advantage for all organisations" (Cooke et al. 2005, see Tsai, Ghoshal 1998). However, this article focuses on macro-level research.

[3] 21 studies analyze firms or households and do not directly focus on spatial units.

of these studies (Rupasingha et al. 2000, Westlund, Calidoni-Lundberg 2007) analysed subnational regions in one country and the organisational density as a measure of social capital in a way that is congruent with this paper's approach (see section 3). From a methodological perspective, these studies did not model spatial interdependence explicitly in their statistical analyses. Only three authors use dummy variables for the regions, fixed effects and/or clustered standard errors to correct for potential spatial clustering (Guiso et al. 2004, Miguel et al. 2005, Westlund, Calidoni-Lundberg 2007). However, Rupasingha et al. (2002) applied spatial regression models to analyse social capital and growth of per capita incomes. The spatial autoregressive and error models show that associational density, as a proxy for social capital, is positively associated with economic growth. The core of this study is whether this is the case for regions in Germany. Thus, the leading hypothesis is *the higher the stock of social capital, the higher the regional economic well-being.*

### *2.3 Spatial dimensions of social capital and economic well-being*

Along the way of analysing the impact of social capital on economic well-being, the fact that the units of analysis are regions, demands attention in further analysis. As spatial units are likely to be interdependent, the assumption of statistical independence of observations in the ordinary regression context may be violated. In order to properly apply statistical analysis and to deduce correct interpretations, one must answer to what degree regions in Germany are dependent in space, but also how these spatial interdependencies look for social capital and economic well-being.

As it is reasonable to assume that regions can benefit from their geographical location, proximity to successful regions may help craft a region's own performance, or contrary to that, unsuccessful regions may negatively influence their neighbours as well. Whether the mechanism that drives interdependencies is a contagion, diffusion or any other process: "near things are more related than distant things" (Tobler 1970) – the *first law of geography* (Tobler 1995, 2004). Although Westlund (2013) raises the argument that "the first law of geography has lost much of its importance and that many distant things nowadays are just as related as near things", it is still relevant because proximity and locality are essential in deducing social capital (David et al. 2010, Glaeser et al. 2002) and economy, even in a globalised world (Cambridge Journal of Regions Economy and Society 2008, Combes et al. 2008, McKinnon, Cumbers 2014, Moretti 2012). Consequently, the outcomes of interdependence cluster in space and in that way differ between regions (Rutten et al. 2010). However, spatial analysis has especially been little connected to social capital so far, regardless of social capital maps having been published. For instance, Beugelsdijk, van Schaik (2005a,b) mapped the social capital's dimensions *trust* and *associations* for the European regions (see also Fazio, Lavecchia 2013). While maps of social capital within a European country are also available (for instance, Italy: Buonanno et al. 2009, Crescenzi et al. 2013; Germany: Franzen, Botzen 2011; Switzerland: Franzen, Botzen 2014, Traunmueller et al. 2012), researchers have turned a blind eye to social capital's spatial patterns. Whether space matters for social capital and economic well-being in Germany, and to what degree adjacent regions are more related than distant regions, is thereby part of this exploratory analysis. In addition to the leading hypothesis, this study investigates the spatial dimensions of social capital and economic well-being by formulating the following exploratory hypotheses: *what exactly are the intricacies of spatial interdependencies of social capital and economic well-being in Germany, and what distance is crucial to the two variables of interest*?

## 3 Measuring social capital and economic well-being in Germany

With the intent to operationalize social capital and economic well-being in line with Putnam's studies, the spatial analysis uses two main data files. It combines an organisational survey representing social capital with regional socio-economic data from official German statistics. The independent variable of interest is the organisational density of voluntary associations – this indicates the stock of *social capital*. Generally, social capital can be deconstructed into cultural and structural aspects (van Deth 2003, among others). Norms

and trust are within this cultural dimension, whereas networks are categorized as the structural aspect of social capital. Networks have been measured with multiple indicators, such as memberships, volunteering, or number of voluntary organisations. Albeit the measurement of social capital has sparked debate (Paldam 2000, Woolcock 2010), this work uses a solid and quantitative measurement, just as Putnam "... tried to measure social capital by counting groups in civil society" (Fukuyama 2001). The number of civic associations per 1000 inhabitants measures social capital in this case. Beside the work of Franzen, Botzen (2011) and Zimmer (2007) there has been little in the way of quantitative information on the scope of social capital in Germany, owing to the fact that all data on voluntary associations is stored locally, and partly handwritten, in federal courts; making a survey costly and time-consuming. In recent years, work has been in progress to ensure that information about Germany's voluntary associations is standardized and accessible through the Statistical Business Register's database. However, in 2012 the local registers still had to be contacted and the Statistical Business Register had to be consulted in order to carry out a complete inventory of all civic associations. The organisational census was conducted at the University of Bern in collaboration with the Stifterverband.[4] Overall, the latest survey counted 580,294 voluntary organisations; on average, this was 7.21 civic associations per 1000 inhabitants. Furthermore, the Federal Statistical Office provides data on the regions' socio-economic characteristics in its Regional Database Germany. The dependent variable is gross domestic product (GDP) per capita (from 2012) that operationalizes regional economic well-being.

The units of analysis in this study are 390 administrative districts in Germany.[5] These sub-national units are called *Landkreise* (districts) and *kreisfreie Städte* (urban districts), subsumed under the nomenclature of territorial units for statistics 3 (NUTS-3 regions). They are the smallest regional units for which associational data can be collected and on which representative data on social capital was surveyed for the very first time. Unfortunately, the variable for *social capital* is therefore not available up until now for smaller areal units such as municipalities. Hence, districts and urban districts best represent the spatial areal unit to show a relationship between social capital and economic well-being. However, *Raumordnungsregionen* (ROR) – also called regional planning regions – may also be suitable for analysis as they are composed of functional regions based on economic dependence. But as they are large-area units (on average composed of four districts), the aggregation of districts can lead to artificial spatial patterns and bias the results of spatial analysis. This concern is known as the *Modifiable Areal Unit Problem* (Openshaw, Taylor 1979). This analysis chooses to deal with the districts instead of ROR because they are four-times more units of analysis as well as the smallest areal units for which data on organisational social capital is available and hence, a proper choice to reveal spatial phenomena.

## 4 Modelling spatial patterns in Germany

As distance and proximity respectively are substantial determinants for economic and social well-being of regions, modelling, detecting, and describing spatial patterns provide insights into social capital and economic well-being among Germany's sub-national regions. The dependence among spatial units of analysis is commonly modelled by means of a *connectivity matrix* or *weighting matrix*. Generally, these matrices are $N \times N$ big and describe how unit $i$ is connected to unit $j$. A frequently used matrix is the nearest-neighbour matrix, which reflects adjacent units with 1 when they are neighbours or $1/d_{ij}$ where $d_{ij}$ is the distance between the neighbours, and 0 for not being

[4] The organizational survey was supervised by the Institute of Sociology at the University of Bern and part of the general project *Placing Civil Society on the Economic Map* (ZiviZ – Zivilgesellschaft in Zahlen), which is lead by the Stifterverband, the Fritz Thyssen Foundation, and the Bertelsmann Foundation.

[5] Currently 402 districts and urban districts exist in Germany. Unfortunately, and due to the data structure at the local registers, the data on voluntary organizations could not be provided separately for 24 districts and urban districts. 12 units of analysis thereby represent both "district" and "urban district". A dummy variable is included to control for the arbitrary nature of these units, indicating these 12 hybrid units in further analysis. For this reason, the number of units in the following analysis is reduced to 390.

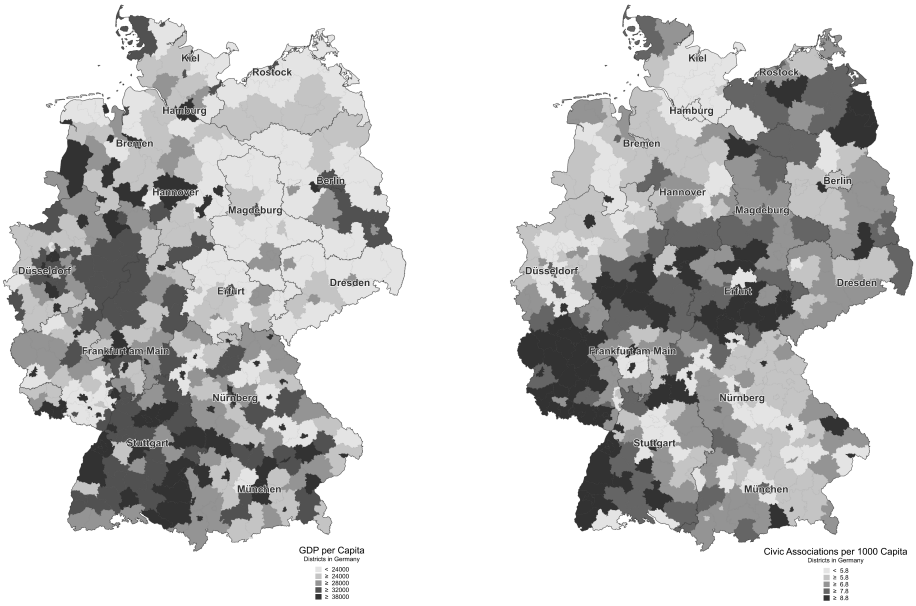
a neighbour. Moreover, interdependence can be based on various mechanisms that drive the interrelations. Researchers can choose between geographical distance and substantive specification to model interdependence. Beck et al. (2006) argued that considering substantive information, such as trading partners in the analysis of the distribution of economy or use multiple spatial matrices in one analysis, might be useful as well (e.g. Hays et al. 2010). According to LeSage, Pace (2011), extending a spatial regression model with multiple matrices of different kinds of connectivity bears pitfalls. Considering this, but also due to the fact that substantive relations are costly to collect, the matrices used here are geographically weighted matrices using kilometres and units that share a border (see equations (1) and (2), which give examples and the corresponding spatially lagged dependent variable).

From an exploratory perspective, the focus lies on which geographic scope is characteristic to regional economic well-being and social capital in Germany. Because closer things matter more, the matrices are chosen in a way so that they represent different gradients of distances with the objective of revealing the geographic scope that matters most to the variables of interest. The first matrix represents the closest neighbours possible: those that share a border. Therefore, $\boldsymbol{W}_1$ is a $N \times N$ binary matrix which codes $w_{ij} = 1$ for regions $i$ and $j$ that do border and $w_{ij} = 0$ for regions that do not border (see equations (1) and (2)). The further matrices increase the distance between regions stepwise in order to analyse spatial patterns gradually. The following matrices are $N \times N$ connectivity matrices and reflect neighbours by different distances $d_{ij}$. Distance is measured as kilometres between the region $i$'s capital and the capital of the neighbouring region $j$; as explorations have shown that capitals and urban districts play a major role in terms of regional economic success. In each matrix $\boldsymbol{W}_{2-12}$, the distance $d_{ij}$ is constrained by one of the kilometre thresholds $x$: $\boldsymbol{W}_2$: $x$=100 km, $\boldsymbol{W}_3$: $x$=150 km, $\boldsymbol{W}_4$: $x$=200 km, $\boldsymbol{W}_5$: $x$=250 km, $\boldsymbol{W}_6$: $x$=300 km, $\boldsymbol{W}_7$: $x$=350 km, $\boldsymbol{W}_8$: $x$=400 km, $\boldsymbol{W}_9$: $x$=450 km, $\boldsymbol{W}_{10}$: $x$=500 km, $\boldsymbol{W}_{11}$: $x$=550 km, and $\boldsymbol{W}_{12}$: $x$=600 km, whereas the gradual increase of each matrix' radius may unveil the distance that matters most to social capital and economic well-being. The maximum distance is equal to the width of Germany. If the distance is greater than $x$-km radius, the weight equals 0. If the distance is equal or less than the $x$-km radius, the weight is the inverse of the distance $d_{ij}$ (see equation (2)), so that the closer a region $j$ is to unit $i$ the larger the weight. Hence, each element of the $N \times N$ matrix either codes $w_{ij} = 0$ or $w_{ij} = 1/d_{ij}$ (see equation (2)).

$$\boldsymbol{W}_1 = \begin{pmatrix} 0 & 1 & 0 & \cdots & 0 \\ 1 & 0 & 0 & \cdots & 1 \\ 1 & 0 & 0 & \cdots & 1 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & 1 & 1 & \cdots & 0 \end{pmatrix} \qquad \boldsymbol{W}y_i = \sum_{j=1}^{k} Y_j \left( \frac{w_{ij}}{\sum_{j=1}^{k} w_{ij}} \right) \tag{1}$$

$$\boldsymbol{W}_{2-12} = \begin{pmatrix} 0 & \frac{1}{d} & 0 & \cdots & 0 \\ \frac{1}{d} & 0 & \frac{1}{d} & \cdots & \frac{1}{d} \\ 0 & \frac{1}{d} & 0 & \cdots & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots \\ 0 & \frac{1}{d} & 0 & \cdots & 0 \end{pmatrix} \qquad \boldsymbol{W}y_i = \sum_{j=1}^{k} \frac{Y_j}{d_{ij}} \quad \text{with } d_{ij} \leq x \tag{2}$$

In the following analyses, all matrices $\boldsymbol{W}_1$-$\boldsymbol{W}_{12}$ are row-standardised by dividing each cell in a row by that row's sum. These matrices are often referred to as row-stochastic, as their elements sum up to one. Row-standardisation has the advantage that the spatial lag has the same scale as the dependent variable $y$ itself. But the normalisation changes the relative weights of the proximal regions when the spatial matrix indicates different numbers of neighbours. As more proximal units are considered, the weight of neighbour $j_k$ becomes smaller. Thus, Pluemper, Neumayer (2010), as well as Ward, Gleditsch (2008), argue that researchers should present substantive justification for row-standardisation. In this example, the transformation is justified because the economic influence of region $j_1$ on region $i$ might be smaller if there are several other adjacent and competing regions $j_{k-1}$, as compared to a case where region $i$ has only one or two neighbours which might have more influence on region $i$'s economy.




(a) Regional economic well-being

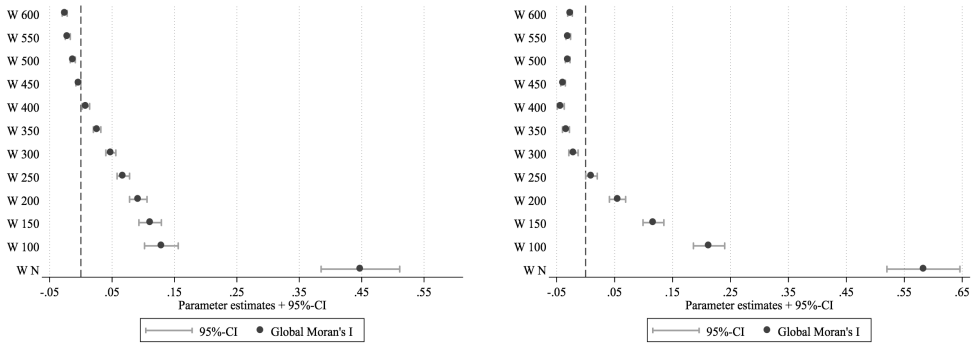
(b) Regional social capital

Figure 1: Maps of economic well-being and social capital (RegioGraph$^{TM}$)

## 5 Exploratory spatial data analysis

Generally, exploratory spatial data analysis (ESDA) tests whether spatial dependence is present in the data. The first simple tool to explore spatial patterns among Germany's sub-national regions is a map of social capital and economic well-being. The maps presented here provide a general impression of the heterogeneous distribution of *economic well-being* (GDP per capita) and *social capital* (civic associations per 1,000 capita) among Germany's districts. Figure 1 pictures such spatial patterns, where the darkest shade refers to the highest quintile. Both indicators heterogeneously spread over the country with a clear east-west decline in the distribution of economic well-being. Moreover, Germany's urban districts exhibit higher GDP than its rural regions. On the other hand, social capital shows no clear east-west difference. Rather, there is what resembles a belt with a higher density of civic associations in the middle of the country. Additionally, in the north and the south, at the ends of the diagonal so to speak, there is a higher density of voluntary organisations.

Spatial heterogeneity is clearly present in Germany's regions in terms of economic well-being and social capital. In order to explore it in more detail, diagnostic tests for univariate spatial autocorrelation will analyse local and global spatial patterns (Anselin 1995, Anselin et al. 1996, Getis 2007). Probably the most frequently used spatial diagnostic tests are Local and Global Moran's $I$ that help to analyse spatial patterns here. Global Moran's $I$ calculates the deviations of $y$ from the mean, to provide an (overall) correlation of an observation's variable $y_i$ with those values $y_j$ of the surrounding regions weighted by the spatial dependency $w_{ij}$ given in the matrix $\boldsymbol{W}$. Moran's $I$ basically reflects the correlation of $\boldsymbol{W}y$ and $y$. Positive values present patterns of similar values and negative coefficients indicate spatial clustering of dissimilar values. The expected value of Moran's $I$ for no autocorrelation with a standardised matrix is $E[I] = -1/(N-1)$ (see Ward, Gleditsch 2008). So if the values of Moran's $I$ are larger than this critical value (in this example -0.0025), global spatial autocorrelation will be positive, whereas a smaller coefficient than the expected value will indicate a negative spatial interdependence, given the $p$-value is $>.05$. The global diagnostic reflects the overall spatial pattern in the data set depending on the spatial weighting matrix, or in other words, on how the analysis employs and constructs connectivity.




(a) Global Moran's $I$ of economic well-being

(b) Global Moran's $I$ of social capital

Figure 2: Global Moran's $I$

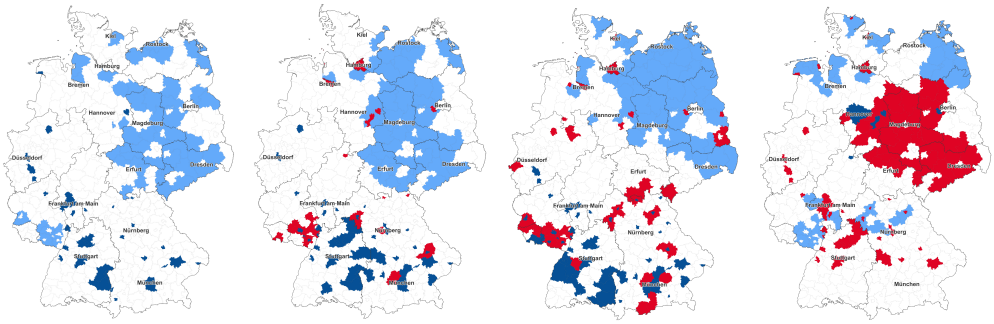
Global Moran's $I$ for the variable *economic well-being* in Germany's 390 regions shows significant spatial association independently of the spatial pattern modelled in the matrices (see Figure 2). The null hypothesis that the variables are randomly distributed in space can therefore be rejected. However, matrices $\boldsymbol{W}_1$ to $\boldsymbol{W}_8$, that reflect regions sharing a border and those up to 400 km distant from one another, indicate positive autocorrelations; for example, regions with higher GDP are surrounded by richer neighbours and regions with lower GDP the opposite. But Global Moran's $I$ reveals a negative spatial association after exploring matrices $\boldsymbol{W}_9$ to $\boldsymbol{W}_{12}$, which consider regions weighted by the distances greater than a 450 km radius. After widening the area under scrutiny, dissimilar clusters of regional GDP appear. This leads to the conclusion that contagion has a certain distance threshold – at about 400 km.

For the variable *social capital*, there is a significant positive global spatial association for the six weighting matrices $\boldsymbol{W}_1$ to $\boldsymbol{W}_6$, whereas the coefficient Global Moran's $I$ changes from positive to negative if the distance threshold is beyond 250 km. In other words, regions with similar social capital (either high or low) are closer to each other where 'close' means 'within a range of 250 km'. At distances beyond this threshold, social capital is negatively correlated in space. Thus, the direction of the global measure's sign for the variable *social capital* changes earlier from positive to negative than for the variable *economic well-being*. To summarize, the distance of regional clusters is fairly different for the stock of social capital and economic well-being in Germany's districts. Social capital appears as locally rooted, whereas economic diffusion and contagion extend to a larger geographic scope.

Local Indicators of Spatial Association (*LISA*) are a decomposition of the global measure (Anselin 1995, p. 97) and are defined as functions of a variable $y$ observed at a region $i$ and of the values of that variable observed in the neighbourhood $j$. They test the null-hypothesis of no spatial autocorrelation for each observation. One of the most common local indicators is Local Moran's $I_i$ (Anselin 1995), which calculated the sub-regional deviations from a global spatial autocorrelation measure and the squared differences in the variable of interest in the neighbourhood respectively. This study calculates significant local spatial accumulation of contrary or similar values for each region of analysis using the Local Moran's $I_i$ for variables *economic well-being* and *social capital*. Exemplary for the gradual increase of distance, Figure 3 represents significant spatial clusters for the variable GDP and civic associations for the weighting matrices $\boldsymbol{W}_1$, $\boldsymbol{W}_2$, $\boldsymbol{W}_6$, and $\boldsymbol{W}_{10}$. The colouring discriminates between similar and dissimilar clusters of significant spatial autocorrelation. Significant spatial autocorrelation is demonstrated by different colors[6]. The light blue illustrates areas of low-low clusters (districts with low values surrounded by low values), whereas the dark blue refers to high-high clusters (regions with high values neighbouring high values). The red represents negative spatial

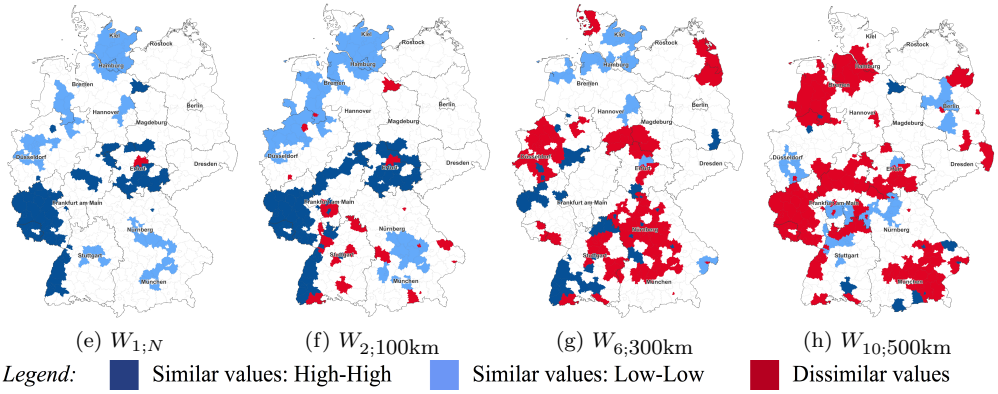
[6]In black and white printouts light blue areas will appear as light grey, red areas as middle grey and dark blue areas as dark grey.

(a) Economic well-being



(a) $W_{1;N}$ (b) $W_{2;100\text{km}}$ (c) $W_{6;300\text{km}}$ (d) $W_{10;500\text{km}}$

(b) Social capital




(e) $W_{1;N}$ (f) $W_{2;100\text{km}}$ (g) $W_{6;300\text{km}}$ (h) $W_{10;500\text{km}}$

Figure 3: Significant Local Moran's $I$ (RegioGraph$^{\text{TM}}$)

autocorrelation, which are spatial clusters of dissimilar values either low-high or high-low patterns. The maps show that significant low-low clusters of economic well-being are concentrated in the east, whereas significant clusters of high values are accumulated in the south. Despite the fact that spatial patterns of social capital are more heterogeneous, one can notice significant clusters of high values in the south-west and in the middle of Germany. Most importantly, Figure 3 demonstrates that the greater the distance modelled in the weighting matrix $\boldsymbol{W}$, the more dissimilar the clusters. This supports the first law of geography that "near things are more related than distant things". In Germany, exploratory analysis has shown that different distance thresholds affect spatial similarity. Local patterns of similar spatial dependencies are found particularly for social capital. However, spatial patterns of economic well-being diffuse wider.

## 6 Spatial regression analysis

ESDA suggests that the data contains regional spatial clusters. This spatial interdependence must be considered in further statistical analyses on the well-being of regions in Germany. Interdependence violates the regression assumption that observations should be independent so that the errors are uncorrelated. Thus, ignoring significant spatial clustering in the error term of an OLS model potentially leads to biased standard errors and inefficient parameter estimates; while omitting spatial dependence as an explanatory variable may bias parameter estimates (LeSage, Pace 2009). In spatial econometrics, the spatial autoregressive lag and the spatial error model have so far been the most widely applied models to address spatial clustering in the data (Anselin 1988, Elhorst 2014, p. 9 for an overview). The researcher need only decide whether the correlation in space is substantial and can be modelled explicitly in a lag model (SAR), or if it is related to some unobserved variable and as a result should be built into the disturbances of the

regression model (SEM) (see equations (3) and (4)).

$$\text{SEM:} \quad y = \boldsymbol{X}\beta + \epsilon; \qquad \epsilon = \lambda \boldsymbol{W}\epsilon + u \tag{3}$$

$$\text{SAR:} \quad y = \rho \boldsymbol{W}y + \boldsymbol{X}\beta + \epsilon \tag{4}$$

Additionally, following Elhorst's (2010, p. 16) recommended approach, statistical diagnostics help strengthen the argumentation for (or against) a spatial regression model when they identify if there is autocorrelation in the OLS-regression residuals (Anselin et al. 1996, Buse 1982). This analysis conducts Moran's $I$ in combination with the classic and robust Lagrange-Multiplier tests for spatial interdependence among the regression residuals so as to show significant autocorrelation. The tests suggest that spatial interdependence should be modelled in further statistical analysis but do not favour either model. Hence, a combination of the lag and the error model might seem appealing. A linear combination of the SEM and SAR respective data generating processes leads to the Spatial Durbin Model (SDM) (LeSage, Pace 2009, p. 30f), which implements a spatially lagged dependent variable $\boldsymbol{W}y$ as well as spatially lagged explanatory variables $\boldsymbol{WX}$ (see equation (5)).

$$\text{SDM:} \quad y = \rho \boldsymbol{W}y + \boldsymbol{X}\beta + \gamma \boldsymbol{WX} + \epsilon \tag{5}$$

Researchers suggest one should prefer this model against others because its major virtue is the ability to generate unbiased coefficient estimates (Elhorst 2010, LeSage, Pace 2009, amongst others). This is the case regardless of the underlying spatial process. One might prefer an even more general model combining all three spatial components: a spatially lagged dependent variable, spatially lagged error term, and spatially lagged explanatory variables simultaneously; however, Elhorst (2010, p. 14) proved that one of the components has to be excluded in order to distinguish the spatial coefficients from each other and to meaningfully interpret them. As a result, SDM "is the best point of departure" (Elhorst 2010, p. 16, LeSage, Pace 2009, p. 46) for regression analysis.

### *6.1 Applied spatial regression analysis*

Spatial regression analysis in this work studies whether social capital is a significant determinant of economic well-being in Germany by foremost testing the relationship between the regional density of civic associations as the indicator of social capital ($SC$) and GDP ($GDP$). A series of control variables $\boldsymbol{X}$ is also included (for details on the variables see Table A.1 in the appendix). The first set of control variables describes regional economic structure (unemployment rate, share of the tertiary sector, number of welfare recipients), human capital (population with university admission), and demographic variables such as the number of immigrants. The second set of control variables additionally captures substantive spatial characteristics of the districts, although spatial patterns are explicitly modelled in the weighting matrices. Particularly, whether a region is, or has an urban district is important to consider because they have a special legal status associated with socio-economic and political characteristics. As Germany's economic success depends on exports, a dummy variable tries to capture diffusion process relationships with neighbouring countries taking 1 when a region borders another country. An additional dummy variable controls for the fact that there are some units encompassing both types of districts (see section 3).

This work estimates different regression models. First, an Ordinary Least Square regression model (OLS) functions here as a baseline for the other regression models. Second, as the SEM and SAR regression models are commonly used in social science research as well as previous spatial diagnostic tests justify both models' use – this work estimates both the SAR and SEM. Even so, it foremost applies the SDM because it is the only model that generates unbiased coefficient estimates independent from the underlying data-generating process. As mentioned, the different spatial regression models implement different spatial lags in the equation. The SEM captures spatial interdependence in the disturbance term, whereas the SAR and SDM model spatial relations as a substantive variable (see equations (6), (7), (8)). This shows that regional GDP levels depend on

neighbouring regions' GDP ($\rho \boldsymbol{W}$GDP). Moreover, the SDM implements the spatial lag of the independent variable *social capital* ($\gamma_1 \boldsymbol{W}$SC), and additionally models that regional GDP relates to socio-economic determinants of spatial neighbours ($\gamma \boldsymbol{WX}$). The spatial matrix $\boldsymbol{W}$ in all spatial regression models is $\boldsymbol{W}_1$ that represents the neighbours that share a border, as it is the matrix with the strongest spatial dependence (see Figure 2). Additionally, previous spatial regression analyses have shown that matrix $\boldsymbol{W}_1$ suits the data best, given the fit statistics of the models. Nevertheless, social capital's estimated effects on economic well-being will be presented in section 6.2 for all spatial matrices that were introduced. This will provide an overview of each matrix' influence. This study's spatial regression models are as follows:

$$\text{SEM:} \quad \text{GDP} = \beta_0 + \beta_1 \text{SC} + \boldsymbol{X}\beta + \epsilon; \qquad \epsilon = \lambda \boldsymbol{W}\epsilon + u \tag{6}$$

$$\text{SAR:} \quad \text{GDP} = \beta_0 + \rho \boldsymbol{W}\text{GDP} + \beta_1 \text{SC} + \boldsymbol{X}\beta + \epsilon \tag{7}$$

$$\text{SDM:} \quad \text{GDP} = \beta_0 + \rho \boldsymbol{W}\text{GDP} + \beta_1 \text{SC} + \gamma_1 \boldsymbol{W}\text{SC} + \boldsymbol{X}\beta + \gamma \boldsymbol{WX} + \epsilon \tag{8}$$

### *6.2 Spatial regression results*

Table 1 and Figure 4 present the spatial regression models and, for the sake of comparability, the OLS model. Results support social capital research's claim and this paper's leading hypothesis: one additional association per 1,000 population corresponds to, on average, an almost 3 point increase in the regional GDP as represented by percentage. Moreover, regions with many inhabitants, lower unemployment rates, a high percentage of college graduates, and higher numbers of immigrants are economically better off, whereas a higher share of the tertiary sector correlates to a lower regional GDP. Bordering Germany's neighbouring countries does not have a significant effect on regional economic well-being. Particularly, urban districts are more prosperous as they are associated with a GDP 35-percentage points higher than districts.

Concerning the spatial coefficients $\lambda$ and $\rho$ in the SAR, SEM and SDM, they reveal the gathering of positive spatial spillovers, where similar values tend to form spatial clusters among Germany's regions. The spatial lag coefficient $\rho$ of the SAR model (2) is significant and reflects neighbourhood clusters with positive spillovers, net of other factors. In addition to the positive spatial lag coefficient, the spatial error coefficient $\lambda$ of the SEM model (3) shows significant positive spatial dependence in the residuals, which indicates determinants that contribute to the regional economic well-being in Germany, but remain absent in the regression model. Likewise, the model fit statistics show better fit for the spatial models than for the OLS. But as differences are not that big, spatial interdependency seems to be a rather minor determinant of economic well-being in Germany.

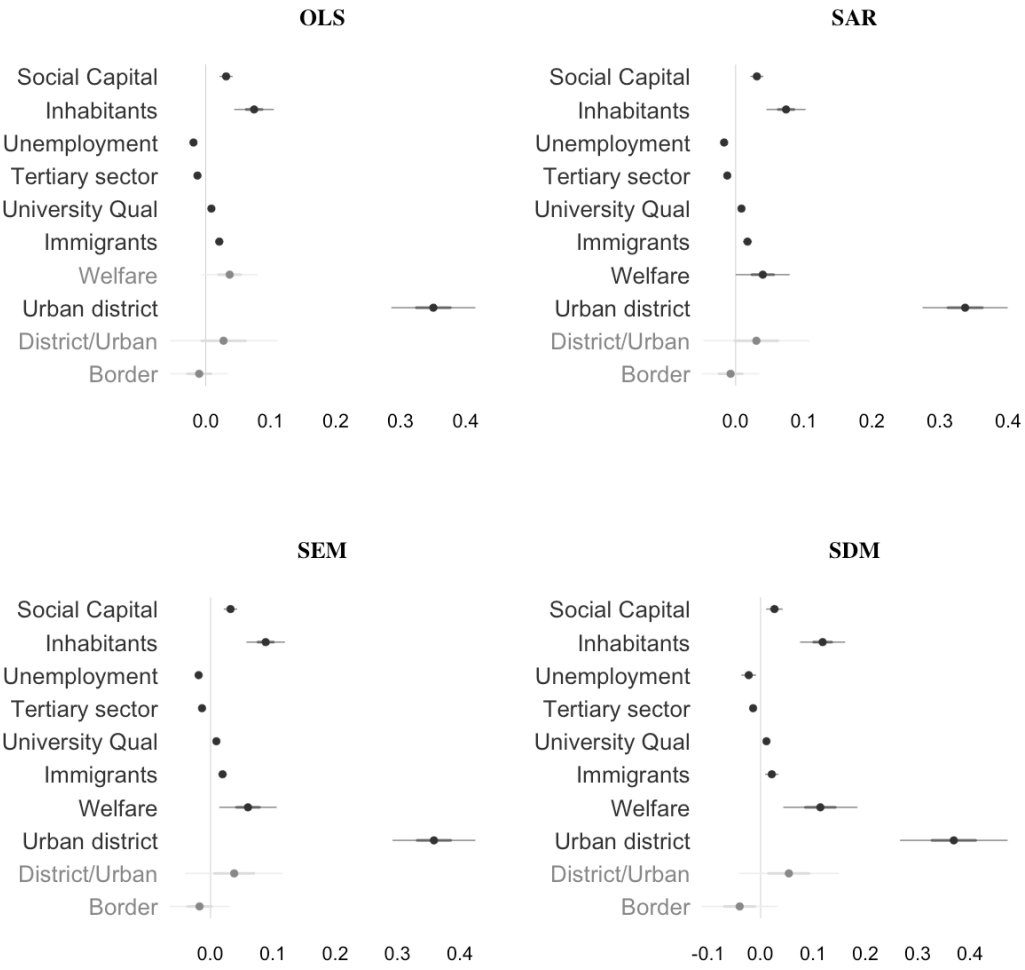
However, when dealing with spatial lags in regression models, the interpretation of estimation results gets more complicated. For example, an increase in a variable in a region may influence its well-being and potentially that in adjacent regions as well. In turn, neighbouring regions may also influence this region. Particularly, the SDM models the potential effects of region $i$ affecting region $j$ with the spatial lags of the dependent variable $\boldsymbol{W}y$ and independent variables $\boldsymbol{WX}$. However, the spatial lag estimation results of the SDM cannot be interpreted directly, as the lag effects are decomposed in the change a region's experience within itself and a region's own influence on its neighbours. The change that directly affects another variable in a region is called a *direct effect*, whereas a change that affects the variable in neighbouring regions is called an *indirect effect*. As these are cumulative impacts, the sum of both effects estimates is called the *total effect* (LeSage, Pace 2009, p. 33f).

Concerning these effects estimates of social capital on economic well-being in Germany (see Table 2 and Figure 5), the estimation shows that a one-association increase per 1,000 inhabitants is related to roughly 2.4 percentage point increase in GDP within a region (direct effect). However, there is no significant indirect effect. Social capital's effect is therefore local, as the direct effect is the only significant estimate. Overall, that the direct effects of explanatory variables within a district on economic well-being outgun the indirect effects on neighbours applies to all variables in the model (except

Table 1: Explaining regional differences in economic well-being using spatial regression models

| | (1) | (2) | (3) | (4) | |
|---|---|---|---|---|---|
| | OLS | SAR | SEM | SDM | |
| **DV: GDP per capita (ln)** | Estimate | Estimate | Estimate | Estimate | Lag |
| (Intercept) | 2.501*** | 2.017*** | 2.333*** | 2.229*** | |
| | (0.220) | (0.319) | (0.222) | (0.438) | |
| **Social Capital** | 0.031*** | 0.031*** | 0.032*** | 0.026** | -0.015 |
| | (0.006) | (0.005) | (0.006) | (0.009) | (0.014) |
| *Socio-economic variables* | | | | | |
| Inhabitants (ln) | 0.074*** | 0.074*** | 0.088*** | 0.118*** | -0.114* |
| | (0.018) | (0.017) | (0.018) | (0.026) | (0.045) |
| Unemployment rate | -0.019*** | -0.017*** | -0.019*** | -0.023** | 0.015 |
| | (0.003) | (0.003) | (0.003) | (0.008) | (0.011) |
| Tertiary sector | -0.013*** | -0.012*** | -0.014*** | -0.014*** | 0.009** |
| | (0.001) | (0.001) | (0.001) | (0.002) | (0.003) |
| Qualification for university | 0.009*** | 0.008*** | 0.009*** | 0.011*** | -0.009** |
| entrance | (0.001) | (0.001) | (0.001) | (0.002) | (0.003) |
| Immigrants | 0.021*** | 0.017*** | 0.019*** | 0.021** | -0.005 |
| | (0.003) | (0.004) | (0.004) | (0.007) | (0.009) |
| Population on welfare | 0.037 | 0.040+ | 0.060* | 0.114** | -0.134* |
| | (0.025) | (0.024) | (0.027) | (0.042) | (0.059) |
| *Spatial variables* | | | | | |
| Urban district | 0.350*** | 0.337*** | 0.358*** | 0.369*** | -0.208+ |
| | (0.039) | (0.037) | (0.040) | (0.062) | (0.110) |
| District/urban district | 0.027 | 0.03 | 0.038 | 0.054 | -0.14 |
| | (0.050) | (0.047) | (0.047) | (0.057) | (0.130) |
| Border | -0.01 | -0.007 | -0.018 | -0.04 | 0.032 |
| | (0.027) | (0.025) | (0.029) | (0.043) | (0.063) |
| *Spatial Coefficients* | | | | | |
| $\rho$ | | 0.144+ | | 0.350*** | |
| (p-value) | | 0.097 | | 0.000 | |
| $\lambda$ | | | 0.419*** | | |
| (p-value) | | | 0.000 | | |
| *Model Fit* | | | | | |
| AIC | -174.027 | -174.783 | -195.374 | -194.198 | |
| Log Likelihood | 99.012 | 100.392 | 110.687 | 120.099 | |

*Notes*: N=390; standard errors in parentheses; ***p <0.001, **p <0.01, *p <0.05, +p <0.1




*Note*: Estimates with confidence intervals.

Figure 4: Illustrating regression results from Table 1 (dark grey denotes significant estimates)

qualification for university). Indeed, the economic well-being of a region heavily depends on its own socio-economic determinants and local characteristics, and less so on those of its neighbours.

Table 2: Direct and indirect effects of socio-economic variables on economic well-being (SDM)

| Variable | Direct Effects | Indirect Effects | Total |
|---|---|---|---|
| **Social Capital** | 0.024*** | -0.007 | 0.017 |
| | (0.000) | (0.488) | (0.171) |
| *Socio-economic variables* | | | |
| Inhabitants (ln) | 0.089*** | -0.082 | 0.007 |
| | (0.000) | (0.062) | (0.926) |
| Unemployment rate | -0.020*** | 0.007 | -0.013 |
| | (0.000) | (0.376) | (0.078) |
| Tertiary sector | -0.013*** | 0.004 | -0.008* |
| | (0.000) | (0.206) | (0.012) |
| Qualification for university | 0.009*** | -0.006* | 0.003 |
| entrance | (0.000) | (0.041) | (0.376) |
| Immigrants | 0.022*** | 0.003 | 0.025*** |
| | (0.000) | (0.756) | (0.000) |
| Population on welfare | 0.076* | -0.106 | -0.03 |
| | (0.013) | (0.051) | (0.589) |
| *Spatial variables* | | | |
| Urban district | 0.337*** | -0.089 | 0.248* |
| | (0.000) | (0.336) | (0.021) |
| District/urban district | 0.005 | -0.138 | -0.133 |
| | (0.942) | (0.385) | (0.462) |
| Border | -0.033 | 0.021 | -0.012 |
| | (0.297) | (0.655) | (0.916) |

Notes: p-values in parentheses; ***p <0.001, **p <0.01, *p <0.05, $^{+}$p <0.1; R package spdep (Bivand, Piras 2015)

The strength of the impacts still depends on how the spatial connectivity is constructed by the spatial weight matrix. Figure 6 shows how social capital's effects estimates depend on the spatial matrices. Nevertheless, effects estimates are robust to the choice of the spatial weight matrix; they are positive and significant across the alternative matrix specifications, supporting the local influence of social capital.

With respect to the substantive robustness of the regression results, modifications modelled whether the positive association between social capital and economic well-being is robust toward other spatial or socio-economic characteristics of the regions.[7] The results show themselves as robust to the implementation of spatial dummy variables for the east or the north of Germany. In particular, the east is historically different from the rest of Germany but nevertheless insignificant in the pursuit of explaining regional well-being while controlling for spatial effects. Moreover, an additional dummy variable indicating metropolises (cities bigger than 500,000 inhabitants) has no influence on economic well-being. Whether the results are robust toward additional controls such as the age structure of the population, the total sex ratio, or for the population density was tested. None of these variables has a significant effect nor do they affect the positive relationship between social capital and economic well-being (see Franzen, Botzen 2011). To address the concern that important predictors were ignored, the preceding regression analyses in section 6.2 were re-estimated with the dependent variable lagged five years $GDP_{t-5}$ to control for previous levels of GDP. This simultaneously controlled for determinants of economic well-being not originally included in the models but correlated with social capital and other significant explanatory variables. The results illustrate that social

[7] The results of the robustness checks are available upon request.

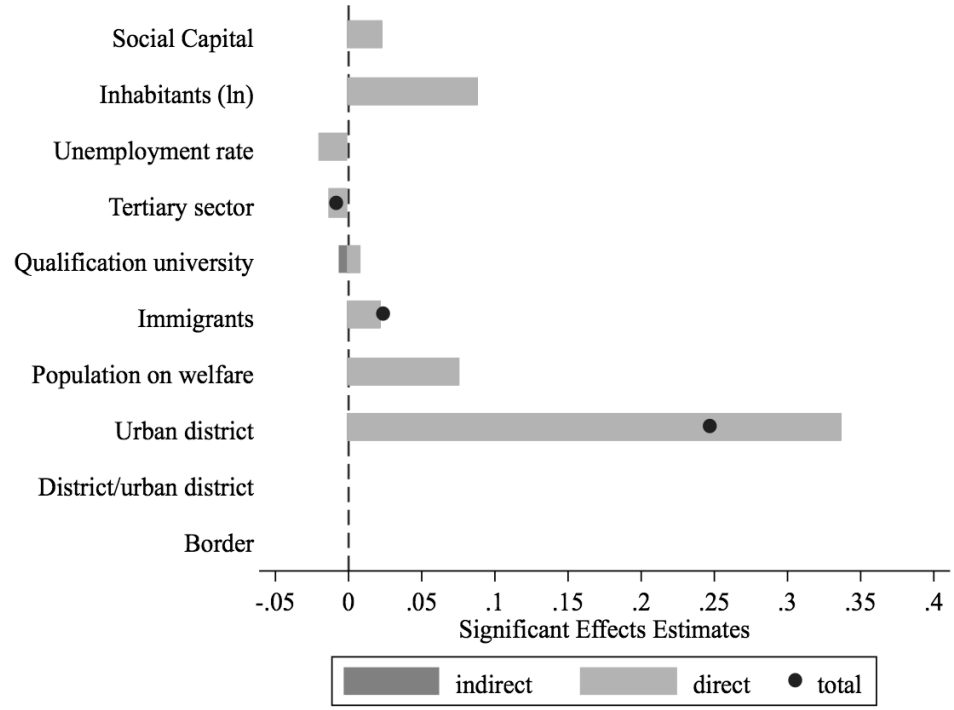



Figure 5: Illustrating significant effects estimates (SDM) of Table 2

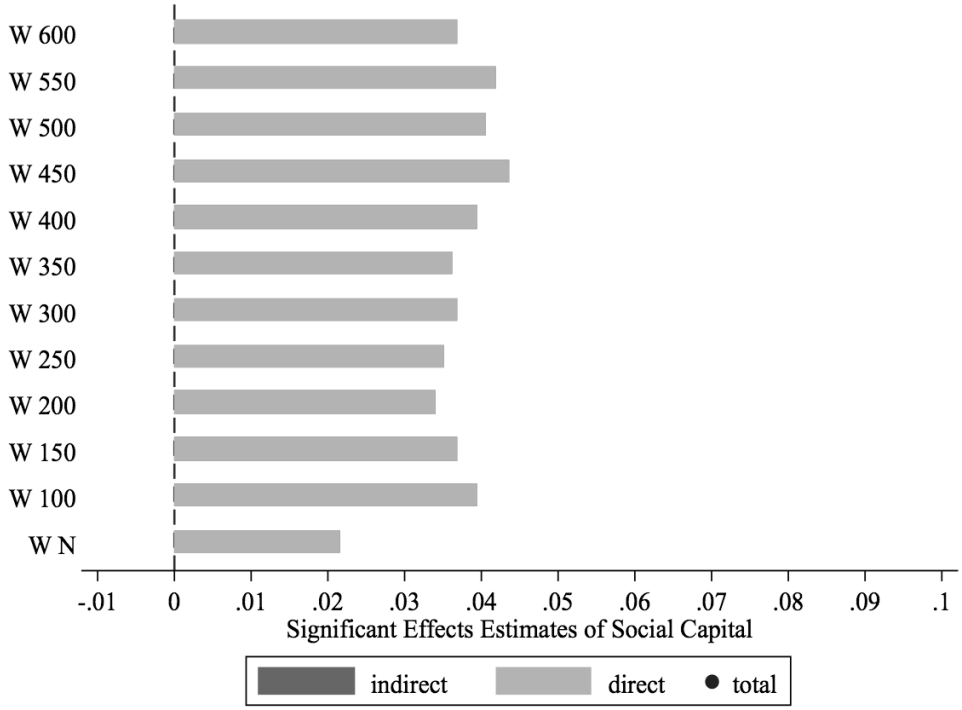



Figure 6: Significant effect estimates of social capital for all spatial weighting matrices (SDM)

capital is still significant and positively associated with economic well-being, net of other control variables and of previous GDP-level (see Figures A.1 and A.2 in the appendix). If the analysis controls for the baseline $GDP_{t-5}$, it yields results that more inhabitants, lower unemployment rate, and a weaker tertiary sector in a region as well as urban districts are still significant determinants and positively associated with higher regional GDP. Compared to previous regressions, economic well-being's correlation with the share of the population with university admission, the rate of immigrants, and the share of welfare recipients diminishes completely (detailed Table A.2 in the appendix).

Moreover, spatial regression results of the explanatory variables are robust to the alternative specification of the weighting matrices. The choice of the spatial weights matrix affects only the spatial coefficient estimates of the spatially lagged variable and the error term. The direction of the explanatory variables' association with economic well-being is also not affected by the matrix specification and the magnitude of the significant estimates only changes slightly. Particularly, social capital effects change only marginally and remain significant. As this paper aims to model spatial effects of regional (sub-national and sub-state level) economic well-being explicitly, it implements different alternatives of spatial dimensions in the weighting matrices. However, one could argue for state dummies to control for spatial patterns. But this proceeding would not allow for spatial effects across state borders and assume that regions of one state belong to the same cluster. In summary, independent of the regression modifications, the significant and positive relationship between social capital and the economic well-being in Germany's regions remains the same.

### *6.3 Discussion*

As this work is based on a finite sample of Germany's districts and focuses on spatial interdependence within that country, the *Boundary Value Problem* confronts it (Anselin 1988). While it is well-known that Germany's economic well-being depends heavily on trade with other countries, this analysis does not account for diffusion processes with regions outside the country's borders. The dummy variable capturing the regions that border another country tries to mitigate this and work against the boundary value problem. This approach is nevertheless limited. This might be one reason for the unexplained dependencies in the spatial error model.

Furthermore, this study applies spatial exploratory and regression analysis, practically excluded in social capital research, but it suffers causal interpretation much like most studies with cross-sectional data. This analysis found a significant positive association between social capital and regional economic well-being as Putnam hypothesized. However, the current analysis does not allow causal inference from the presented results. A properly applied causal analysis would require panel data so as to draw the conclusion that social capital generates economic well-being. It may also be that the causal arrow is in reverse and that social capital is in fact rather a consequence of economic well-being. Even other types of causal analysis can just give additional hints rather than causal proofs without panel data analysis. Although minor studies have showed how propensity score analysis leads to the same findings, it merely provides an additional indication for the effect of social capital on prosperity. Nevertheless, extended hypothesis testing with organisational survey data from Switzerland supports the social capital effect of civic associations on regional economic well-being (Franzen, Botzen 2014). Yet, it could well be that further causal analysis cannot provide evidence that social capital causes economic well-being. However, this would not imply that the magic of social capital is illusive. The mechanisms that civic associations generate trust and facilitate cooperation can still be true, as research has shown (Botzen 2015, Claibourn, Martin 2000). Despite that, the causal path between social capital and its positive externalities such as economic well-being has to be analysed on the aggregate level in detail, although the causal mechanism is measureable at the individual level. Further analysis could thereby focus on the causal analysis and the mechanisms on the macro level; this would help examine whether the "magic of social capital" glows for spatial units.

Aside from the problem of causal inference, the measurement of social capital is also debateable. Despite the fact that the density of civic associations is a common

measure of social capital, called "Putnam's instrument" (Paldam, Svendsen 2000), this is a rather naive operational proxy. Were certain information available for Germany's districts, deeper insight into the mechanism of social capital would have been possible. For instance, the type of the associations (e.g.: field of activity, bonding/bridging distinction), the number of memberships, or the members' activity level might have been valuable statistics. Although some of this information is available for single cities or regions in Germany (Maloney et al. 2008, Zimmer 1992, 2007), a comprehensive nationwide survey of the districts has not so far been realized by the German government or a third party. Systematic quantitative data on social capital would allow properly detailed analyses of other indicators; this is definitely a research gap that must be dealt with in the near future. In addition, detailed data on social capital and its spatial patterns could help flourish interpretation of the exploratory results. Although this work's explorations ascertain the geographic scope of social capital for the first time, the mechanisms behind the different thresholds remain undiscovered. Further data collection and analysis could shed light on why the geographic scope of social capital is smaller compared to the threshold of economic well-being.

Moreover, further research on regional social capital could extend the idea of the weighted matrices to other interdependencies. One might do this by modelling substantive relations between units of analysis such as expenditures for civil society, membership rates, and the share of volunteers in the population (e.g. Beck et al. (2006), as mentioned in section 3). Unfortunately, such substantive data for Germany's administrative districts is not yet available. In addition to using substantive relations as interdependencies, one can extend the spatial model by using more than one weighted matrix. For instance, the multiple spatial models can capture different distances in the weighting matrix. However, these extensions themselves carry pitfalls noted by LeSage, Pace (2011). Nevertheless, methods of spatial econometrics are fruitful and flexible tools that will allow research to model, explore, and analyse interdependence, enriching analysis of social capital and regional well-being.

## 7 Conclusion

This work analysed Putnam's idea that social capital shapes the economic well-being of subnational regions with Germany as its focus. It modelled, explored, and analysed spatial interdependence among 390 districts. Potential interdependence in space was captured by alternative specifications of weighting matrices that represent different geographic scopes and spillovers. Cross-sectional regression analysis applied three well-established spatial models and effects estimates.

Exploratory and regression analysis reveals that social capital and economic well-being are spatially clustered in Germany, compared to a random assignment. However, each variable's radius of influence is different. Economic well-being has a larger sphere of spillovers, whereas the scope of social capital is rather regional. According to ESDA, the distance threshold of positive spatial correlation for economic well-being is at 450 km, while similar spatial patterns of social capital have a radius of less than 250 km. Likewise, effects estimates of the SDM reveal that only direct effects are significant. Accordingly, social capital is locally associated with economic well-being but has no effects on adjacent regions. Hence, this result underpins exploratory insights, suggesting social capital acts rather regionally. With regard to multivariate spatial analyses, the substantive interpretation of the regression models supports the social capital hypothesis, as the results show that associations matter for economic well-being, even as a macro-level variable. Regarding the specification of the spatial weighting matrices, regression results are robust to the alternatives. Foremost, the positive relationship between social capital and regional economic well-being remains the same. In sum, adequate spatial analysis of subnational German units supports Putnam's hypothesis, that social capital is positively associated with the wealth of regions.

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## A Appendix

Table A.1: Descriptive statistics of variables

| *Variable* | *Measurement* | *Mean* | *Std.Dev.* | *Min* | *Max* | *Origin* |
|---|---|---|---|---|---|---|
| Social Capital | associations per 1000 capita | 7.365 | 1.840 | 3.583 | 13.019 | Survey |
| GDP (ln) | GDP per capita in 1000€(ln) | 3.438 | 0.327 | 2.772 | 4.789 | |
| Urban district | dummy, Yes =1 | 0.249 | 0.433 | 0 | 1 | |
| District/urban district | dummy, Yes =1 | 0.044 | 0.204 | 0 | 1 | |
| Border | dummy, Yes =1 | 0.167 | 0.373 | 0 | 1 | |
| Inhabitants (ln) | number of inhabitants (ln) | 11.998 | 0.661 | 10.43 | 15.062 | |
| Unemployment rate | % of unemployed in population | 7.436 | 4.35 | 1.6 | 57.856 | Regional Database |
| Tertiary sector | % of tertiary sector of GVA | 50.028 | 8.403 | 22.701 | 74.904 | Germany |
| Qualification university | % of pupils with "Abitur" (qualification for university entrance) of all graduated pupils | 34.415 | 8.911 | 13.061 | 62.588 | |
| Immigrants | % of immigrants in population | 7.448 | 4.449 | 0.795 | 26.771 | |
| Population on welfare | % of welfare recipients in population | 1.328 | 0.504 | 0.332 | 3.349 | |

Table A.2: Explaining regional differences in economic well-being using spatial regression models, robustness test with lagged $GDP_{t-5}$

| | (1) | (2) | (3) | (4) | |
|---|---|---|---|---|---|
| **DV: GDP per Capital (ln)** | OLS Estimate | SAR Estimate | SEM Estimate | SDM Estimate | Lag |
| (Intercept) | 0.188$^{+}$ | 0.132 | 0.164 | 0.454$^{*}$ | |
| | (0.109) | (0.155) | (0.109) | (0.201) | |
| **Social Capital** | 0.006$^{*}$ | 0.006$^{**}$ | 0.007$^{*}$ | 0.007$^{+}$ | -0.006 |
| | (0.002) | (0.002) | (0.003) | (0.004) | (0.006) |
| GDP (ln) 2008 | 0.949$^{***}$ | 0.942$^{***}$ | 0.953$^{***}$ | 0.970$^{***}$ | -0.374$^{***}$ |
| | (0.023) | (0.027) | (0.023) | (0.030) | (0.090) |
| *Socio-economic variables* | | | | | |
| Inhabitants (ln) | 0.017$^{*}$ | 0.018$^{*}$ | 0.017$^{*}$ | 0.018 | -0.020 |
| | (0.008) | (0.008) | (0.008) | (0.012) | (0.02) |
| Unemployment rate | -0.003$^{+}$ | -0.002$^{+}$ | -0.003$^{*}$ | -0.008$^{*}$ | 0.009$^{+}$ |
| | (0.001) | (0.001) | (0.001) | (0.004) | (0.005) |
| Tertiary sector | -0.003$^{***}$ | -0.003$^{***}$ | -0.002$^{***}$ | -0.002$^{*}$ | 0.000 |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Qualification for university | 0.000 | 0.000 | 0.000 | 0.001 | -0.002 |
| entrance | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Immigrants | -0.001 | -0.001 | -0.001 | -0.001 | 0.004 |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.004) |
| Population on welfare | -0.012 | -0.011 | -0.008 | 0.013 | -0.032 |
| | (0.011) | (0.011) | (0.012) | (0.019) | (0.026) |
| *Spatial variables* | | | | | |
| Urban district | 0.041$^{*}$ | 0.042$^{*}$ | 0.036$^{+}$ | 0.029 | -0.004 |
| | (0.018) | (0.018) | (0.019) | (0.029) | (0.049) |
| District/urban district | -0.016 | -0.016 | -0.019 | -0.024 | 0.010 |
| | (0.021) | (0.021) | (0.02) | (0.025) | (0.057) |
| Border | 0.005 | 0.006 | 0.005 | 0.009 | -0.008 |
| | (0.011) | (0.011) | (0.012) | (0.019) | (0.027) |
| *Spatial Coefficients* | | | | | |
| $\rho$ | | 0.022 | | 0.336$^{***}$ | |
| (p-value) | | 0.63 | | 0.000 | |
| $\lambda$ | | | 0.352$^{***}$ | | |
| (p-value) | | | 0.000 | | |
| *Model Fit* | | | | | |
| AIC (Linear model) | -839.902 | -838.13 | -852.85 | -840.85 | |
| Log Likelihood | 432.951 | 433.07 | 440.42 | 445.42 | |

*Notes*: N=390; standard errors in parentheses; $^{***}$p <0.001, $^{**}$p <0.01, $^{*}$p <0.05, $^{+}$p <0.1

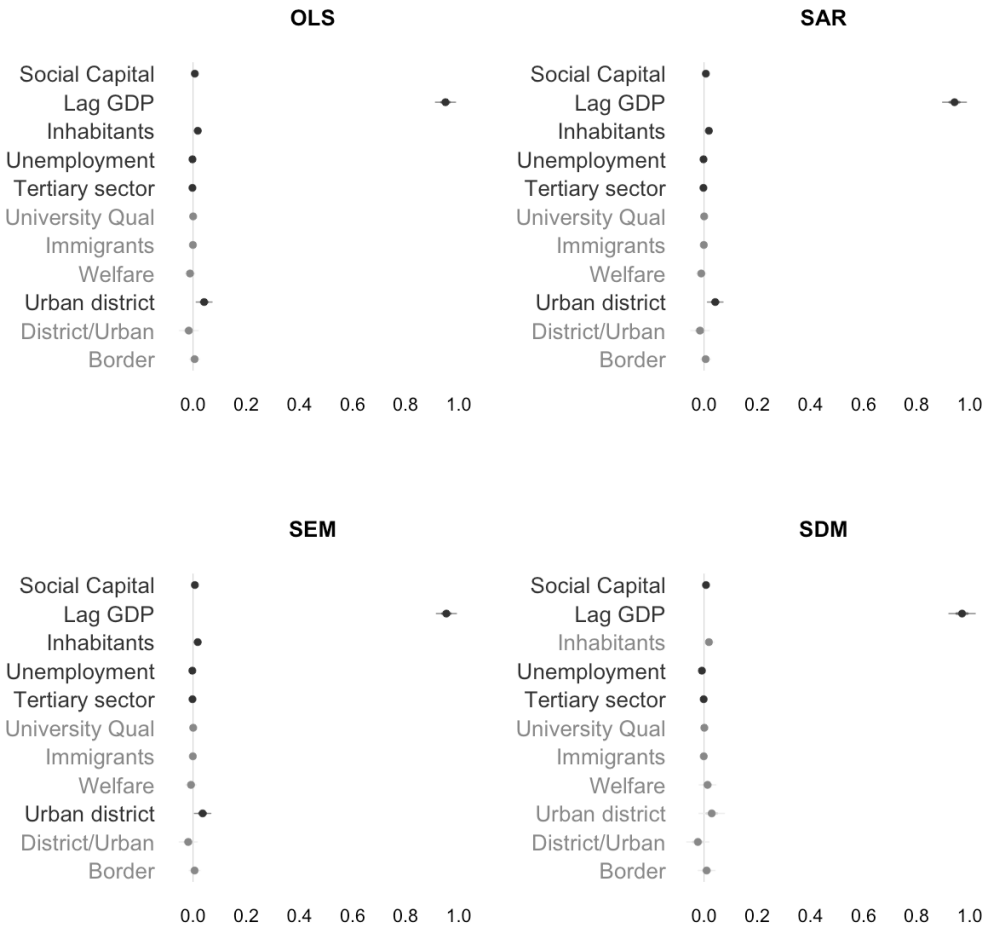


Figure A.1: Spatial regression results, robustness test with lagged $\text{GDP}_{t-5}$ (dark grey denotes significant estimates

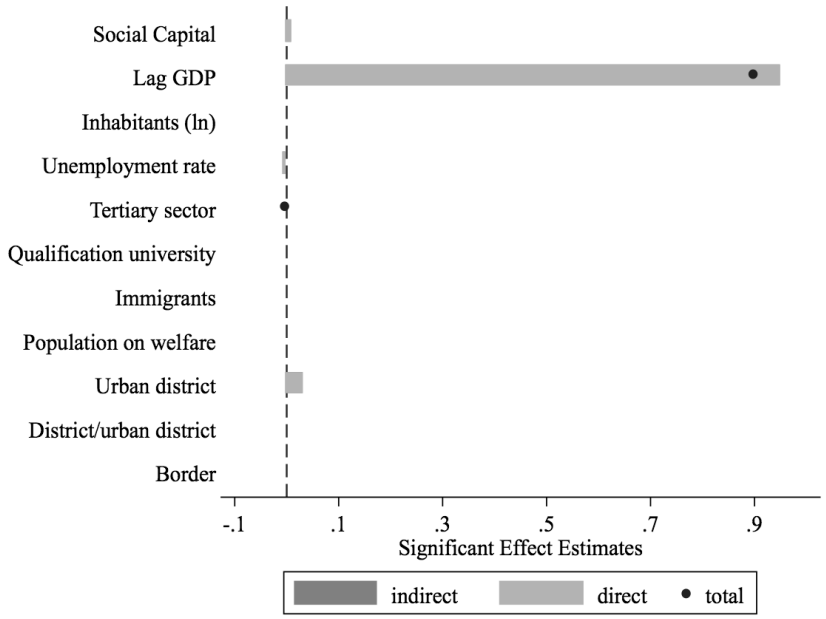


Figure A.2: Illustrating significant effects estimates of the SDM from Table A.2 (direct and indirect effects)

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# Increasing innovativeness of SMEs in peripheral areas through international networks? The case of Southern Italy*

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**Abstract.** Strengthening innovation capacity of European small and medium enterprises (SMEs) by means of their participation in the Sixth (FP6-SME) and Seventh (FP7-SME) Framework Programmes was an important objective of the European Union policies. Since SMEs form the backbone of the Italian economy, their strong presence in an international network such as the one fostered by the European Union represents a great opportunity, particularly for firms located in southern Italy – the marginal macro-area of the country in terms of innovation – to increase their competitiveness. Based on the major literature on topics such as knowledge exchange, innovation networks and disparities, and on descriptive statistics and a cluster analysis in a dynamic perspective, our study aimed to assess the actual intra-regional, extra-regional and transnational links established by the Italian SMEs and public research establishments (PREs). In the next step we assessed whether knowledge flows fostered by the FP6-SME and FP7-SME were mainly concentrated in the traditionally winning macro-regional areas (North and Center) or led to more widespread benefits in favor of SMEs located in the marginal South. The findings of our study revealed a very limited number of connections – with a related weak knowledge exchange – involving the southern regions, implying a reinforcement of innovation activities in the traditionally most dynamic industrial areas of the country.

## 1 Introduction

The European Union (EU) confers a key role to micro, small and medium enterprises (SMEs) and considers them the engines of the European economy as well as essential sources of jobs and creators of innovation and an entrepreneurial spirit. Furthermore, SMEs are considered by the EU as crucial economic entities to foster competitiveness and employment. According to the EU, Horizon 2020 actively supports SMEs by providing both direct financial and indirect supports to increase their innovation capacity.

In this respect, both the Sixth (FP6) and Seventh (FP7) Framework Programmes already included themes (FP6-SME and FP7-SME) specifically created to benefit this type of organization with the objectives to "strengthen the innovation capacity of European SMEs and their contribution to the development of new technology-based products and markets, bridge the gap between research and innovation by helping SMEs outsource

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research, increase their research efforts, extend their networks, better exploit research results and acquire technological know-how" (European Commission 2012).

Specifically, SMEs form the real backbone of the Italian economy: 99.9% of the Italian enterprises have fewer than 250 employees and 95% have fewer than 10 employees (ISTAT 2013b).

According to various studies and reports (ISTAT 2013a, Svimez 2015), the fragmentation of the Italian economic-production framework in a myriad of micro firms and SMEs is precisely one of the major factors hindering the level of productivity and the low degree of innovation in the country as a whole and particularly in the Southern regions (Wired & Cotec 2009, Svimez 2015). The Italian socio-economic fabric is characterized by evident and long-lasting disparities between the northern and central regions (which are to varying extents the most advanced areas of the country) and the southern ones (A'Hearn, Venables 2011).

Most industrial activities in Italy are historically concentrated in the North, particularly in the so-called "Industrial Triangle" of Lombardy, Piedmont and Liguria, whereas some northern and central regions such as Veneto, Emilia Romagna, Tuscany and Marche saw the flourishing implementation of several dense and strongly related SME-based Marshallian industrial districts in the 1970s and 1980s. They contributed to create the so-called "Third Italy", a successful sociological definition which distinguishes this peculiar form of industrialization from the "First Italy" (the industrial heartland of the Northwest) and the "Second Italy" (the marginal Southern regions) (Bagnasco 1977, Trigilia 1986, Scott 1988, Sforzi 1989).

In the last fifteen years several indicators (average annual growth, unemployment rate, lack of public and foreign direct investments, etc.) have negatively characterized the socio-economic performances of Italy, whose cumulative growth (20.6%) in the period 2000-2013 was the lowest in the euro area (37.3%), even lower than Greece (24%).

In this general weak framework the southern regions have mostly suffered the effects of the economic crisis started in the 2008, compared with the other two macro-areas of the country (North and Center). Factors such as the extremely weak production system – causing very low competitiveness and productivity – and the lack of human capital caused by significant migrations of skilled workers to other areas of the country or even abroad emphasize the socio-economic divergence in the Italian development path. The real risk for the southern regions is that a cyclical crisis could turn into permanent underdevelopment (Svimez 2015).

Starting from this perspective, we analyzed all the projects involving at least one Italian organization (i,e. SME or public research establishment, PRE) funded under the FP6-SME and FP7-SME in order to determine the actual presence of organizations located in a peripheral area in terms of innovation (e.g. Southern Italy) within the innovation networks created under the two latest FPs.

Specifically, our aim was to answer the following research questions: Which is the actual presence of SMEs and PREs located in the eight southern Italian regions (Abruzzo, Apulia, Basilicata, Calabria, Campania, Molise, Sardinia and Sicily) in the two latest FPs specifically devoted to SMEs? And did these SMEs benefit from the knowledge flows created by the collaborations encouraged by the aforementioned research programs?

The dataset we use focuses on projects funded by the EU. The dataset covers a period of 12 years (divided in two time-lapses, 2002-2006 for FP6, and 2007-2013 for FP7), with these EU-funded projects serving as some of the best environments to create and disseminate research results and knowledge (European Commission 2007).

The theoretical basis for the present case study has been provided by this latter consideration and by the findings of several previous studies which stress the importance for companies located in peripheral areas to create and strengthen connections with near and distant international partners (Bathelt et al. 2004, Meier Zu Köcker et al. 2011, Fitjar, Rodríguez-Pose 2011a,b, Gust-Bardon 2012), in order to successfully produce innovation and generate beneficial "network effects" (Autant-Bernard et al. 2007).

These studies suggested that knowledge exchange is a critical factor in innovation dynamics and a very good proxy to capture the effects of industrialization by adopting a spatial perspective.

Therefore, following the indications of the European Commission (2013) and a previous study regarding the impact of innovation network dynamics on regional re-industrialization processes (Calignano, Quarta 2015), we hypothesize that the presence of extremely centralized relational clusters in the EU research network is symptomatic of a strengthening in the polarization of innovation activities in the winning regions, whereas more diffuse network structures bring more widespread benefits in favor of SMEs located in peripheral areas in terms of innovation (European Commission 2013).

A dynamic approach (i.e., considering two distinct periods related to the two latest FPs[1]), descriptive statistical techniques and cluster analysis were adopted for processing the data concerning the collaboration established by the Italian SMEs and PREs throughout the FP6-SME and FP7-SME.

The paper is organized as follows: In the next section, the major literature referring to the main topics tackled in the article is reviewed to provide the theoretical background of the study; in Section 3 the methodology adopted for the study is outlined, by illustrating also the main characteristics of the dataset we used and justifying its choice; in Section 4 (divided in four different sub-sections) the results of the case study are broadly illustrated; finally, in Section 5 the major findings of the study are discussed and the conclusions presented.

## 2 Knowledge, innovation, networks and disparities: A theoretical framework

In recent years innovation networks and knowledge exchange became increasingly central topics in innovation studies with a spatial background (i.e., Frenken 2000, Simmie 2003, Bathelt et al. 2004, Hassink 2005, Asheim et al. 2007, Autant-Bernard et al. 2007, Hagen 2008, Binz, Truffer 2011, Marrocu et al. 2013). The great interest towards these subjects sprang especially from the channels and mechanisms through which innovation is nowadays created, shared and diffused.

In fact, the advent of the so-called knowledge-based economy (Brinkley 2006) in the current era of globalization has led to a sharp transition from a "closed" to a new "open" model of innovation (Chesbrough 2003).

In a nutshell, in the old model of closed innovation, firms used to generate the ideas that they intended to develop, manufacture and commercialize relying exclusively on their own labs and resources and by trying to employ the most skilled workers on the job market. Furthermore, these innovative companies defended the advantage deriving from their new inventions from the risk posed by competitors 'decoding' the product and using the outsourced and materialized knowledge by means of intellectual property rights. Finally, the virtuous cycle of innovation was driven by the commercial success and profits deriving from the new inventions, leading to new investments in R&D and additional breakthrough discoveries.

However, the advent of globalization led to significant changes in innovation and its related dynamics – such as knowledge exchange – in recent decades (Storper 1999).

In the current mutable global economic scenario companies are hardly able to take high risks in terms of R&D or carry out by themselves extensive research leading to new products with an uncertain commercial success. Furthermore, two other factors have determined the transition from a closed to an open model of innovation in most industries: First, the higher mobility of knowledge workers made it increasingly difficult to control proprietary ideas and expertise for companies; and secondly, the rise of new successful

[1] Several changes occurred in the transition from the FP6 to the FP7 including a larger budget, a longer duration (increased from 5 to 7 years) and a new mechanism aiming to enhance long-term private-public partnerships (i.e. the so-called Joint Technologies Initiatives). Furthermore, an accentuated international dimension and a special attention devoted to SMEs (including a package close to 1 billion euros) are both features of the more recent FP. However, even though all these relevant differences certainly influenced the number of regional organizations in terms of overall participations, they did not affect the dynamic approach we adopted and the results of our comparison. This consideration is based on the fact that our statistical and cluster analyses were carried out within each FP and that the aforementioned changes pertained indiscriminately to all the organizations which participated to either the FP6 or FP7.

firms which were supported by the growing availability of private venture capital financing spilling out from the large companies' research labs.

According to the open innovation model, the boundaries between companies and their surrounding environments are porous and companies develop their ideas both within and outside them, by implying new ways to create value and a new logic embracing external ideas and knowledge in conjunction with internal R&D (Chesbrough 2003).

These considerations at the management level are particularly interesting when a spatial perspective is adopted by suggesting a relational nature and a collaborative dimension of innovation which involves networks of actors at different levels and distances (Balland et al. 2015).

Knowledge exchange determined by collaborations among organizations at various geographical scales can be considered an essential prerequisite in dynamics leading to innovation (Calignano, Quarta 2015).

Even though spatial proximity is still perceived as a competitive advantage (Gust-Bardon 2012) and geographical proximity remains a critical factor in favoring knowledge exchange among closely located organizations (Sonn, Storper 2008), at the same time various studies have highlighted how other forms of proximity (such as cognitive, organizational, social and institutional proximities: Boschma 2005) and long-distance collaborations increasingly matter and have a positive influence in innovation dynamics both at the regional and national levels (Frenken 2000, Asheim, Isaksen 2002, Lagendijk, Lorentzen 2007, Fitjar, Rodríguez-Pose 2011a,b).

In other words, in the last few decades innovation spaces have been dramatically redesigned and characterized by significant changes in the production and diffusion of knowledge (Scherngell, Barber 2010). These changes led to a higher number of long distance collaborations and partnerships determining a related increasingly swift importance of innovation networks at the transnational level (Wagner, Leydesdorff 2005, Autant-Bernard et al. 2007, Maggioni, Uberti 2011).

These latter aspects are relevant especially for firms located in peripheral areas, since they can take advantage from R&D inputs and knowledge flows from both adjacent (Moreno et al. 2005, Rodríguez-Pose, Crescenzi 2008) and distant (Asheim, Isaksen 2002, Lagendijk, Lorentzen 2007, Fitjar, Rodríguez-Pose 2011a,b) partners and regions. In other words, changes in the global economy have made the connections among organizations at the international level increasingly prominent by highlighting contextually the benefits brought by their internationalization. Similarly, the establishment of strong links between distant organizations with complementary strengths is one of the best ways for businesses to obtain access to more recent technology, best skills and most promising markets (Meier Zu Köcker et al. 2011).

In sum, regional firms should aim at both learning from each other and developing sound relationships with partners located in other geographical areas around the world in order to improve their innovation capabilities (Gust-Bardon 2012).

The innovation activities of the SMEs located in Southern Italy – the economic entities and macro regional areas this paper refers to – are characterized by a very weak institutional, socio-economic and industrial fabric and are negatively affected by the loss-making historical trajectories of the area. The active and successful participation of these organizations located in disadvantaged or peripheral regions in national or international research programs is negatively influenced precisely by the aforementioned aspects (Calignano, Quarta 2015).

More broadly, the concepts just expressed take the name of 'path dependence' and refer specifically to an open system evolving in ways shaped by its past development paths (Boschma, Martin 2010) which can either negatively or positively affect the socio-economic fabric of an area.

However, even though less developed regions certainly face difficulties in changing their innovation process models and in breaking out their path dependence, economic scenarios are subject to substantial changes (Boschma, Martin 2007), and in the past the adoption of different paths was possible in some regions or countries and it will be possible for less developed ones in the future (Pylak 2015).

With regard to old industrial areas, Hassink (2010, p. 452) argues that regional lock-in

"refers to a set of interrelated lock-ins that manifest themselves at the regional level, but are influenced and affected by both intra-regional and extra-regional factors". One of these factors is the lack of renewal in the past development paths which firms can successfully tackle by focusing on innovation and diversification.

With this empirical evidence and these theoretical premises as our basis, we looked at the projects funded under the two latest FPs with the aim to determine the actual presence and the connections created by the Italian SMEs and PREs at the intra-regional, extra-regional and transnational levels.

As stated above, we argue that a network characterized by more diffuse structures brings more widespread benefits in favor of SMEs located in peripheral areas, whereas the presence of centralized networks is the symptom of a reinforced polarization in innovation activities in the most advanced areas of the country (European Commission 2013, Calignano, Quarta 2015).

A recent study was carried out in a similar vein with the purpose to assess the spatial relationships and verify the impact of innovation dynamics on regional re-industrialization processes in Italy (Calignano, Quarta 2015). However, that study neglected transnational links despite the characteristics of the FPs and the increasing importance played by international collaborations in knowledge exchange leading to innovation and competitiveness (Asheim, Isaksen 2002, Autant-Bernard et al. 2007, Lagendijk, Lorentzen 2007, Frenken et al. 2009, Fitjar, Rodríguez-Pose 2011a,b, Maggioni, Uberti 2011). The present article enabled us to narrow the gap in this respect.

## 3 Dataset and methodology

The 1523 projects funded under the FP6-SME and FP7-SME were chosen as a dataset for the empirical aspects of this study for several reasons.

In a previous study aiming to assess the processes of re-industrialization and regional disparities in Italy (Calignano, Quarta 2015) it was already stressed that knowledge dynamics – like those ones encouraged by the collaborations established within the FPs – are only one of the drivers of the industrial development. Consequently, the actual effects of this latter can be equally influenced by other significant factors such as investment funds, infrastructures and human capital. However, as highlighted above, we can confidently assert that knowledge exchange based on collaborations and partnerships is a very reliable relational data to capture innovation dynamics in a spatial perspective (e.g. Fitjar, Rodríguez-Pose 2011a,b).

Furthermore, other funding schemes are expressly implemented to support the economic agents located in the lagging areas and are likely more attractive than the FPs for the SMEs and PREs located in the peripheral regions. Among these, the EU Structural Funds (SF) are specifically designed to narrow the gap between the more and less developed areas of the EU by offering broad financial support to the organizations located in the disadvantaged regions. The aim of this specific EU regional policy measure is to support projects and initiatives such as "developing infrastructure network, supporting enterprises, investing in education, research and innovation activities as well as in environmental protection programmes" (Busillo et al. 2010 cited in Barkovic et al. 2013).

A recent study aiming to reveal the effectiveness of the SF precisely in Southern Italy revealed very limited positive effects in terms of employment, population and house prices during the period 2007-2013 (Ciani, De Blasio 2015) by confirming the findings of other studies detecting the impact of the place-based policies implemented in Italy partially financed with EU money (Bronzini, De Blasio 2006, Accetturo, De Blasio 2012, Andini, De Blasio 2014).

The relevant findings of the aforementioned studies can be considered complementary to the results of our paper. In fact, by following several previous studies (e.g. Calignano 2014, Calignano, Quarta 2015), the research projects funded under the FP6 and FP7 enabled us to focus specifically on the collaborative dimension of knowledge dynamics aiming to strengthen the innovativeness within the EU countries. This latter is an aspect that cannot be captured by means of the analysis of the projects funded under the SF for two main reasons: First, the broader scope of the SF (even though "Research and

Innovation" is a relevant theme); and second, the beneficiaries of the financing (i.e. single organizations, not research groups).

Furthermore, other significant factors such as the intrinsic characteristics of the FPs, the research methods we adopted, and the theoretical and empirical aspects outlined in the previous sections pushed us to choose the collaborations created within the two latest FPs as our dataset and enabled us to carry out the study successfully.

First of all, one of the characteristics of the FPs is transcalarity, an element which enables researchers to capture relational and spatial collaboration dynamics among organizations by considering various geographical scales. In our case study intra-regional, extra-regional and transnational ties were considered in order to determine the actual presence, knowledge flows and potential clusters of regions with regard to the Italian SMEs and PREs involved in the FP6-SME and FP7-SME. Specifically, with the term "intra-regional" we refer to collaborations between two organizations of the same constitutional/administrative region (NUTS 2); the term "extra-regional" refers to ties established between organizations of two different regions of the same country; finally, "transnational" relations are those involving pairs of organizations belonging to two different countries.

Secondly, the adoption of a dynamic approach (i.e. considering two distinct periods, 2002-2006 for FP6 and 2007-2013 for FP7) allowed us to analyze all the research projects funded by the EU in a significantly long period and to assess whether important changes occurred with regard to the knowledge flows created by the organizations located in a country throughout the two periods considered.

Thirdly, the projects funded under the FP6-SME and FP7-SME cover a very wide range of traditional and technological sectors and industries (textile, ceramic, agro-food, aquaculture, ICT, chemistry, pharmaceutical, automotive, etc.). As a consequence, this aspect allowed us to assess from a global viewpoint the level of interaction and the related knowledge actually exchanged among SMEs and PREs located in different regions and macro-areas of the country.

Finally, the choice of our dataset is justified by the fact that social proximity (Boschma 2005) and temporary and direct contacts (Torre 2008) seem to be more relevant than mere geographical proximity in the EU innovation networks created under the FPs (Calignano 2014).

The findings of these studies suggested that innovation primarily takes place in global innovation networks or innovation systems and that we can look confidently at the ties established by organizations within the EU research network to understand how knowledge exchange dynamics work globally in a country from a spatial and relational viewpoint.

With specific regard to Italy, other studies have revealed how the success rate of the Italian proposals in the European context was one of the highest in absolute terms (Silvani 2010). Moreover, Italian organizations consider EU funds to be one of the most important sources of research financing by virtue of the greater freedom of action and the high availability of grants and financial resources if compared with the scarce funds allocated at the national level (Calignano 2014). Even though the latter information refers to a different FP – the Nanosciences, Nanotechnologies, Materials and New Production Technologies – on the basis of the current socio-economic scenario (ISTAT 2013b, Svimez 2015) we can confidently assert that the same motivations also pushed the Italian entrepreneurs and scientists to apply for the two latest FPs expressly created for the benefits of SMEs.

From an operational viewpoint, following the theoretical premises and empirical evidences previously outlined we have analyzed all the projects funded under the FP6-SME and FP7-SME in order to reconstruct the knowledge flows created and strengthened by the Italian SMEs and PREs. We have specifically focused on those projects with at least one Italian participant. Then, we grouped the partners of each project into pairs checking whether each pair belonged to the same region, different regions or different countries (corresponding to intra-regional, extra-regional and transnational collaboration networks). By following this method and adopting descriptive statistics and cluster analysis we were able to determine if most of the partnerships were gathered inside one macro-area or between different macro-areas of the country, as well as the connections established by the regional organizations at the transnational level and the presence of clusters including regions characterized by similar spatial behavior.

## 4 Italian organizations in the FP6-SME and FP7-SME

In the next four sub-sections the percentage of participation by Italian SMEs and PREs in the FP6-SME and FP7-SME will briefly be analyzed in comparison with the other countries actively involved in the two latest FPs and with consideration for the differences found at the regional level (4.1). Furthermore, the intra-regional and extra-regional ties (4.2) and the transnational connections (4.3) established by Italian SMEs and PREs will be revealed in the following two sub-sections, with the aim to show in which areas of the country the knowledge flows fostered by the two latest FPs were mainly concentrated. Finally, in Section 4.4 the Italian regions will be clustered on the basis of the number of their intra-regional, extra-regional and transnational links (i.e. the three aggregated variables which allow us to reveal the presence of clusters based on the spatial behavior of the regional organizations located in Italy).

### *4.1 Italian participation at the national and regional levels*

The proportion of participation at the national level was calculated with the aim to reveal the ranking of Italy in comparison with other countries actively involved in the FP6-SME and FP7-SME, and in order to assess whether significant changes occurred in transition from the first to the second period considered.

Table 1 shows the top 10 countries in terms of participation as concerns the FP6-SME and FP7-SME. With the term "participation" we refer to the presence of each country's organizations without considering the number of organizations actually involved. And as each organization may participate more than once, we use the term "participations" to refer to the amount of times organizations participated in the aforementioned programs.

Table 1: Participation in the FP6-SME and FP7-SME: National level. Calculated from the Cordis dataset (European Commission 2015).

| **Ranking** | **FP6-SME** | | | **FP7-SME** | | |
|---|---|---|---|---|---|---|
| 1 | United Kingdom | 823 | 14.40% | Spain | 1406 | 15.40% |
| 2 | Germany | 767 | 13.40% | United Kingdom | 1352 | 14.80% |
| 3 | Spain | 719 | 12.60% | Germany | 945 | 10.30% |
| **4** | **Italy** | **581** | **10.20%** | **Italy** | **829** | **9.10%** |
| 5 | France | 342 | 6.00% | France | 471 | 5.10% |
| 6 | Netherlands | 267 | 4.70% | Greece | 370 | 4.00% |
| 7 | Poland | 222 | 3.90% | Netherlands | 329 | 3.60% |
| 8 | Norway | 172 | 3.00% | Norway | 326 | 3.60% |
| 9 | Austria | 161 | 2.80% | Belgium | 285 | 3.10% |
| 10 | Sweden | 161 | 2.80% | Sweden | 244 | 2.70% |

Generally speaking, out of the top-10 most active countries both in the FP6-SME and FP7-SME, 8 countries confirmed their presence (e.g. Spain, United Kingdom, Germany, Italy, France, Netherlands, Norway and Sweden). The main difference between the two FPs concerns the ranking of Spain, which passed from the third to the first position by overcoming two big and important countries, namely the United Kingdom and Germany. Another significant difference is the presence of Greece and Belgium in the more recent FP: This is due to their increased amount of participation and the simultaneous decrease of Polish and Austrian participation (the two countries ranked in the top-10 in the FP6).

Italy is ranked fourth in both FPs and – even though the percentage of Italian participation decreased (-1.1% in the transition from the FP6-SME to the FP7-SME) – it can be certainly considered as one of the most active countries in absolute terms and one of the countries that profited most from the funds allocated under the FP6-SME and FP7-SME. However, the participation of Italian SMEs and PREs was not the same in the various regions and macro-regional areas throughout the two latest FPs. As highlighted in the following maps (Figure 1), the greatest amount of participation is concentrated in the northern and, to a lesser extent, in the central regions of the country. In fact,

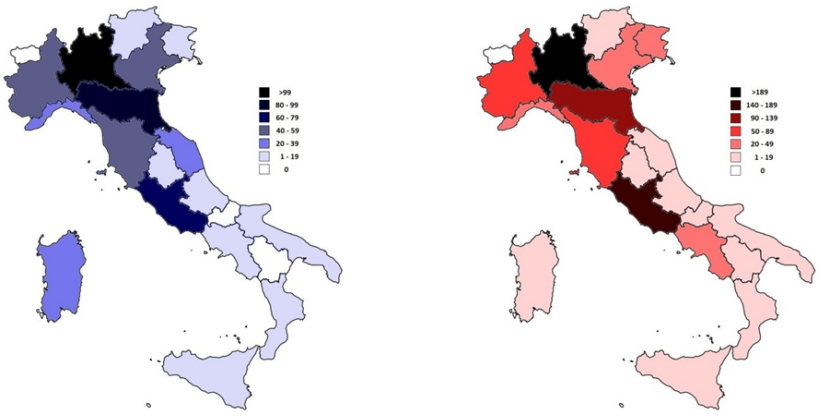


Figure 1: Participations of Italian SMEs and PREs in the FP6-SME (left) and FP7-SME (right): Italian regions. Calculated from the Cordis dataset (European Commission 2015).

aggregating the data at the macro-regional level reveals that 64.7% of participations in the FP6 and 61.2% in the FP7 were concentrated in the northern areas of the country. Lombardy is the leading region in both FPs (123 participations in the FP6 and 238 in the FP7), followed by Emilia Romagna (80 participations in the FP6 and 106 in the FP7) and Lazio (75 participations in the FP6 and 143 – ranked second before Emilia-Romagna – in the FP7)[2]. The number of participations of SMEs and PREs located in Southern Italy is very limited if compared with the other two macro-regional areas of the country: Only 9.6% of participations in the FP6 and 9.4% in the FP7 saw the presence of the organizations located in the southern regions. All the southern regions are ranked in the lower range (1-19 participations) in both FPs, with the only exceptions being Sardinia in the FP6 and Campania in the FP7, both of whose participations were slightly higher than the lower range (respectively 23 and 21 participations).

The number of Italian SMEs and PREs participating in the FP6-SME and FP7-SME per 1,000 firms was calculated in order to "weigh" the absolute number of regional participations on the basis of the actual number of SMEs with fewer than 250 employees operating in each region. Table 2 shows similar results if compared with the previous maps related to the participation of Italian organizations in absolute terms (Figure 1) by highlighting that only northern and central regions scored above the national average.

### *4.2 Knowledge flows inside and between the Italian regions and macro-regional areas*

After revealing the degree of activity of Italy and the level of participation of the organizations belonging to the various Italian regions and macro-regional areas, a dynamic approach was used to assess the knowledge flows created by the Italian SMEs and PREs at the intra-regional, extra-regional and transnational levels throughout the FP6-SME and FP7-SME.

First of all, the number of intra-regional and extra-regional ties established by the Italian SMEs and PREs throughout the FP6-SME and FP7-SME were calculated (illustrated in Table 3). The two Italian regions with the highest number of intra-regional links in the FP6-SME were Lombardy and Emilia Romagna (respectively 117 and 83): These intra-regional ties represented 50% of the intra-regional links at the national level and revealed an absolute concentration in the two aforementioned regions. The third

[2]Each sheet regarding the projects funded under the FP6 and FP7 is available on the website of the CORDIS (Community Research and Development Information Service) and contains information about the single organizations participating in the projects. This information includes the address of the organization, the administrative contact and their telephone number. The address of the public national research centers (e.g. the Consiglio Nazionale delle Ricerche – National Research Council) refers always to the central headquarters in Rome (Lazio), even though the administrative contacts and their related telephone numbers refer to the person and the separate branch actually involved. The risk to overestimate the number of participations of Lazio was prevented by reconstructing the branch actually involved in the projects by means of a thorough search on Google based on the names of the administrative contacts and their related telephone numbers.

Table 2: Participation of Italian SMEs and PREs in the FP6-SME and FP7-SME per 1000 SMEs: Italian regions. Calculated from the Cordis dataset (European Commission 2015); and Industry Services Census (ISTAT 2011).

| **FP6-SME** | | | **FP7-SME** | | |
|---|---|---|---|---|---|
| **Region** | **Macro area** | **Participants per 1000 SMEs** | **Region** | **Macro area** | **Participants per 1000 SMEs** |
| *Liguria* | *North* | *0.27* | *Lazio* | *Center* | *0.34* |
| *Emilia-Romagna* | *North* | *0.22* | *Liguria* | *North* | *0.3* |
| *Umbria* | *Center* | *0.2* | *Lombardy* | *North* | *0.29* |
| *Lazio* | *Center* | *0.18* | *Emilia-Romagna* | *North* | *0.29* |
| *Friuli-Venezia Giulia* | *North* | *0.17* | *Friuli-Venezia Giulia* | *North* | *0.25* |
| *Marche* | *Center* | *0.16* | *Tuscany* | *Center* | *0.21* |
| *Tuscany* | *Center* | *0.15* | *Piedmont* | *North* | *0.19* |
| *Lombardy* | *North* | *0.15* | **Italy (Nat. Av.)** | **-** | **0.18** |
| *Veneto* | *North* | *0.15* | Trentino-Alto Adige | North | 0.17 |
| *Trentino-Alto Adige* | *North* | *0.14* | Umbria | Center | 0.16 |
| **Italy (Nat. Av.)** | **-** | **0.13** | Molise | South | 0.14 |
| Piedmont | North | 0.12 | Basilicata | South | 0.11 |
| Sardinia | South | 0.12 | Apulia | South | 0.08 |
| Apulia | South | 0.04 | Veneto | North | 0.08 |
| Calabria | South- | 0.04 | Abruzzo | South | 0.07 |
| Abruzzo | South | 0.03 | Sardinia | South | 0.07 |
| Campania | South | 0.03 | Campania | South | 0.06 |
| Sicily | South | 0.03 | Marche | Center | 0.06 |
| Basilicata | South | - | Calabria | South | 0.04 |
| Molise | South | - | Sicily | South | 0.03 |
| Aosta Valley | North | - | Aosta Valley | North | - |

region at the national level was Sardinia, even though the southern region did not confirm the result in the following FP7-SME, passing from 38 intra-regional links established in the FP6-SME to only 5 links (on the same low level as the other southern regions). Moreover, Lombardy (87 intra-regional links) confirmed its first position in the FP7-SME, followed by Lazio (81, the highest increase in absolute terms in the transition between the two FPs) and Emilia Romagna (52). The number of intra-regional links in the southern macro-regional area was very limited: Only 51 links were found in the FP6-SME and 23 in the FP7-SME (25% and even 7.5% of the total, respectively).

Extra-regional links showed similar figures. In fact, Lombardy confirmed its first position in both FPs (217 links in the FP6-SME and 189 in the FP7-SME), followed by Lazio (respectively 121 and 132) and Emilia-Romagna (respectively 123 and 127). The higher number of extra-regional collaborations in the FP7 compared with the FP6 found in Lazio and Emilia-Romagna did not reflect the results showed by most Italian regions. For instance, central and northern regions such as Tuscany and Veneto more than halved the number of extra-regional collaborations in the transition from the first to the second period considered (passing respectively from 122 to 50 and from 107 to 42). The results of the southern regions were once again disappointing: The higher number of extra-regional links in southern Italy was found in Campania (38 in the FP6-SME and 24 in the FP7-SME, which are 17.5% and 12.6% of Lombardy, the region ranked first).

Following the same method, we aggregated data related to intra-regional links at the macro-regional level with the purpose to reveal inside and between which macro-areas of the country collaborations encouraged by the two latest FPs mainly occurred.

The next two diagrams (Figure 2) show graphically the knowledge exchange involving SMEs and PREs located in the three macro-areas of the country. Specifically, the dimension of the spheres indicate the number of links established by the Italian organizations within their macro-areas; the thickness of the lines illustrates the number of links between two different macro-areas (the thicker the line is, the greater the ties' intensity); and the

Table 3: Intra-regional and extra regional ties in the FP6-SME and FP7-SME: Italian regions. Calculated from the Cordis dataset (European Commission 2015).

| Region | Macro area | Intra-regional links | | | | Extra-regional links | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | FP6 SME | % | FP7 SME | % | FP6 SME | % | FP7 SME | % |
| Abruzzo | South | - | - | - | - | 5 | 0.5 | 10 | 1.2 |
| Aosta Valley | North | - | - | - | - | - | - | - | - |
| Apulia | South | 5 | 1.3 | 6 | 2.0 | 13 | 1.3 | 20 | 2.5 |
| Basilicata | South | - | - | 1 | 0.3 | - | - | 6 | 0.7 |
| Calabria | South | 1 | 0.3 | 3 | 1.0 | 8 | 0.8 | 3 | 0.4 |
| Campania | South | 3 | 0.8 | 8 | 2.1 | 38 | 3.7 | 24 | 3.0 |
| Emilia-Romagna | North | 83 | 20.8 | 52 | 17.1 | 123 | 11.8 | 127 | 15.8 |
| Friuli-Venezia Giulia | North | 7 | 1.8 | 3 | 1.0 | 30 | 2.9 | 32 | 4.0 |
| Lazio | Center | 26 | 6.5 | 81 | 26.6 | 121 | 11.6 | 132 | 16.4 |
| Liguria | North | 11 | 2.8 | 10 | 3.3 | 84 | 8.1 | 57 | 7.1 |
| Lombardy | North | 117 | 29.3 | 87 | 28.6 | 217 | 20.9 | 189 | 23.4 |
| Marche | Center | 22 | 5.5 | 1 | 0.3 | 33 | 3.2 | 12 | 1.5 |
| Molise | South | - | - | - | - | - | - | - | - |
| Piedmont | North | 12 | 3.0 | 19 | 6.3 | 51 | 4.9 | 51 | 6.3 |
| Sardinia | South | 38 | 9.5 | 5 | 1.6 | 20 | 1.9 | 15 | 1.9 |
| Sicily | South | 4 | 1.0 | 0 | - | 8 | 0.8 | 11 | 1.4 |
| Tuscany | Center | 29 | 7.3 | 21 | 6.9 | 122 | 11.7 | 50 | 6.2 |
| Trentino-Alto Adige | North | 4 | 1.0 | 1 | 0.3 | 31 | 3.0 | 16 | 2.0 |
| Umbria | Center | 9 | 2.0 | - | - | 29 | 2.8 | 9 | 1.1 |
| Veneto | North | 28 | 7.0 | 6 | 2.0 | 107 | 10.3 | 42 | 5.5 |
| **Total** | **-** | **399** | **100** | **304** | **100** | **1040** | **100** | **806** | **100** |

figure in or in proximity to the spheres indicates the exact number of links established within a macro-area, whereas the figure positioned beside the lines refers to the exact number of links established between different macro-areas.

The number of links decreased drastically both inside the same macro-area and between different ones in the transition from the FP6-SME to the FP7-SME, despite the increased number of Italian participations. These figures depend on the lower number of organizations involved in the projects funded under the FP7-SME if compared to the previous FP (specifically, the average of participants in projects with at least one Italian organization was 13.7 in the FP6 and 11.4 in the FP7). Beyond this general consideration, what we can observe when looking at the links established among SMEs and PREs located in the same or different macro-regional areas is the highest concentration of collaborations in the North (450 links in the FP6-SME and 294 in the FP7-SME) and a good number of collaborations both between the North and the Center (220 links in the FP6-SME and 160 in the FP7-SME) and in the Center (112 in the FP6-SME and 83 in the FP7-SME).

On the other hand, connections in the South (40 in the FP6-SME and 22 in the FP7-SME) and between the South and the other two macro-regional areas were very limited. In this respect, one of the major changes in the transition between the two FPs was the balance of ties established by the SMEs and PREs located in the South with the ones located in the other two macro-regional areas: the South-Center relationship was stronger in the FP6-SME (52 links versus the 35 links established with the North), whereas the South-North connection was stronger in the following period (50 links versus the 24 links established with the Center).

### *4.3 The transnational links established by the Italian SMEs and PREs*

The analysis carried out in the previous section enabled us to determine the intra-regional and inter-regional knowledge flows created by the Italian SMEs and PREs through the projects funded under the FP6-SME and FP7-SME. The figures showed a strong concentration of collaborations in the northern macro-regional area and a very good

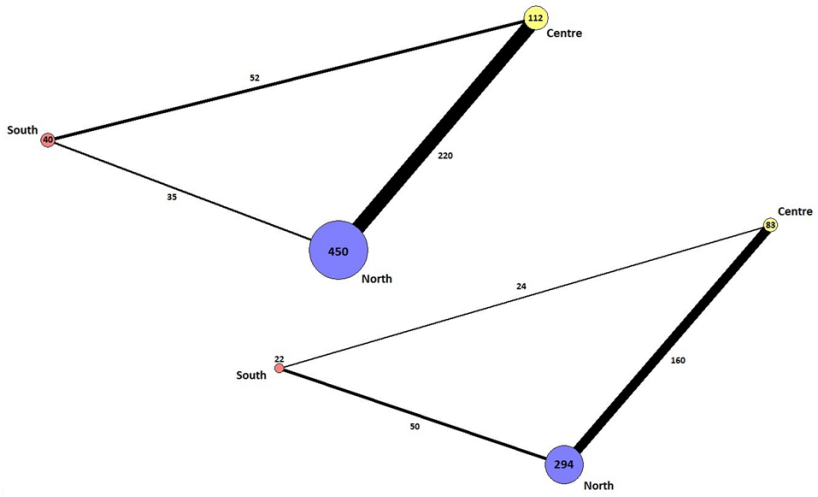


Figure 2: Intra-regional and extra-regional knowledge flows in the FP6-SME and FP7-SME: Italian macro-regional areas. Calculated from the Cordis dataset (European Commission 2015); and NetDraw Network Visualization (Borgatti 2002).

number of ties established between organizations located in the northern and central areas of the country, with a shortage of links involving southern SMEs and PREs both at the intra-regional and extra-regional levels.

However, following our theoretical premises, for the intrinsic characteristics of the FPs and considering the purposes of the present study, a further level of analysis regarding transnational collaborations must be added. This type of analysis enabled us to determine the number of transnational collaborations involving the Italian SMEs and PREs and consequently to assess if organizations located in Southern Italy were able to connect themselves to important international nodes, as various studies suggest them to do (Meier Zu Köcker et al. 2011, Gust-Bardon 2012).

The next table (Table 4) shows in detail the transnational collaborations established by the Italian organizations located in the twenty constitutional regions together with the related percentage. Lombardy showed again the highest scores both in the FP6-SME and FP7-SME (1517 ties, 23% of the total in the FP6, and 1737 ties, 29.6% of the total in the FP7), followed by Lazio (685, 10.5% of the total in the FP6, and 1022, 17.4% in the FP7) and Emilia Romagna (1043, 16% of the total in the FP6, and 716, 12.2% in the FP7). The only other region with a percentage of transnational collaborations higher than 10% was Tuscany (10.1% in the only FP6). All the other regions played the second fiddle with regard to the transnational collaborations established by the SMEs and PREs located within their boundaries

The regional data regarding the transnational collaborations were also aggregated at the macro-regional level in order to reveal in which parts of the country most transnational collaborations were gathered. The figures depicted in the next table (Table 5) show clearly how two thirds of the transnational collaborations involved northern regions both in the FP6-SME and FP7-SME. Once again, a shortage of transnational collaborations was observed especially in the South: Only about 9% of the total links at the national level were established in the southern regions with regard to both the detected FPs.

### *4.4 The hierarchy of the Italian regions in the FP6-SME and FP7-SME: A Cluster Analysis*

The figures deriving from the distinct analysis regarding the intra-regional, extra-regional and transnational collaborations established by the Italian organizations in the two latest FPS were grouped with the purpose to reveal the presence of clusters based on collaborations gathered at various geographical levels. Specifically, intra-regional, extra-regional and transnational collaborations calculated for each Italian region represented the three variables used to determine the presence of clusters based on the characteristics

Table 4: Transnational links in the FP6-SME and FP7-SME: Italian regions. Calculated from the Cordis dataset (European Commission 2015).

| **Region** | **Macro-Area** | **Transnational links** | | | |
|---|---|---|---|---|---|
| | | **FP6-SME** | **%** | **FP7-SME** | **%** |
| Abruzzo | South | 22 | 0.3 | 42 | 0.7 |
| Aosta Valley | North | - | - | - | - |
| Apulia | South | 107 | 1.6 | 135 | 2.3 |
| Basilicata | South | - | - | 22 | 0.4 |
| Calabria | South | 56 | 0.9 | 50 | 0.9 |
| Campania | South | 132 | 2.0 | 115 | 2.0 |
| Emilia-Romagna | North | 1043 | 16.0 | 716 | 12.2 |
| Friuli-Venezia Giulia | North | 114 | 1.7 | 159 | 2.7 |
| Lazio | Center | 685 | 10.5 | 1022 | 17.4 |
| Liguria | North | 348 | 5.3 | 240 | 4.1 |
| Lombardy | North | 1517 | 23.3 | 1737 | 29.6 |
| Marche | Center | 195 | 3.0 | 48 | 0.8 |
| Molise | South | - | - | 17 | 0.3 |
| Piedmont | North | 396 | 6.1 | 406 | 6.9 |
| Sardinia | South | 199 | 3.1 | 110 | 1.9 |
| Sicily | South | 74 | 1.1 | 63 | 1.1 |
| Tuscany | Center | 661 | 10.1 | 528 | 9.0 |
| Trentino-Alto Adige | North | 141 | 2.2 | 97 | 1.7 |
| Umbria | Center | 191 | 2.9 | 94 | 1.6 |
| Veneto | North | 639 | 9.8 | 261 | 4.5 |
| **Total** | **-** | **6520** | **100** | **5862** | **100** |

Table 5: Transnational links in the FP6-SME and FP7-SME: Italian macro-regional areas. Calculated from the Cordis dataset (European Commission 2015).

| **Macro-area** | **Transnational links** | | | |
|---|---|---|---|---|
| | **FP6-SME** | | **FP7-SME** | |
| | **Total** | **%** | **Total** | **%** |
| North | 4198 | 64.4 | 3616 | 61.7 |
| Center | 1732 | 26.6 | 1692 | 28.9 |
| South | 590 | 9.0 | 554 | 9.4 |

of the participations of the Italian regions in the two latest FPs. From a methodological viewpoint, hierarchical clustering and the nearest neighbor method were preferred and adopted. Specifically, hierarchical clustering enabled us to determine the presence of bottom up clusters based on the actual presence and spatial behaviors of the SMEs and PREs located in each Italian region. In other words, the use of the nearest neighbor algorithm – according to which the distance between two clusters must equal the distance between their two closest members – enabled us to highlight clearly the similarity in the elements making up a cluster. In fact, the nearest neighbor method attributes more importance to the homogeneity among the elements of a group rather than differentiating sharply the various clusters.

The next diagrams (Figure 3) illustrate the major clusters we identified and their features: specifically, the x-axis refers to the number of intra-regional collaborations, the y-axis illustrates the number of extra-regional links, and the dimension of the spheres shows the different number of transnational links (bigger spheres correspond to a higher number of transnational links). Finally, the color of each sphere determines a different cluster. Following the method described above, four different major clusters grouping regions according to the number of their intra-regional, extra-regional and transnational links were

found. With regard to the FP6-SME, Lombardy and Emilia-Romagna correspond to two different major clusters composed of one single region. These two clusters are characterized by a high level of activity as for extra-regional and transnational collaborations (Emilia Romagna) and a higher number of links for each geographical scale considered (Lombardy), even though Lombardy could be undoubtedly considered as the most active region in absolute terms dominating both the FPs at the national level. Behind these two clusters, a third cluster characterized by regions with similar spatial and relational features was formed by five northern and central regions including Lazio, Liguria, Piedmont, Tuscany and Veneto. The main characteristic of this cluster is to be formed by regions with an intermediate level of ties at the various geographical scales. Finally, in the fourth and last cluster all the other regions showing a lower level of interaction were grouped.

The main changes assessed in the transition from the FP6-SME to the FP7-SME regarded the position of Lazio – passed from the third to the second cluster – which formed a new group together with Emilia-Romagna, and the fewer number of organizations making up the third cluster (in the second period formed only by Tuscany and Piedmont). Finally, two regions historically characterized by a strong concentration of industrial activities such as Liguria and Veneto were absorbed by the last cluster. These figures showed an increasing concentration in the level of activity – implying the presence of centralized networks – in only five regions (Lombardy, Lazio, Emilia Romagna, Piedmont and Tuscany) forming 3 out of 4 observed clusters. As a consequence, one very important finding in our study is that all the southern Italian regions belong to the fourth and less active cluster, therefore confirming again the scarce propensity demonstrated by the SMEs and PREs located in the South to create and strengthen strong links at every geographical scale considered.

## 5 Discussions of the major results and conclusions

Starting from the theoretical considerations and empirical evidences regarding the importance for firms located in peripheral areas to cooperate at various geographical levels in order to improve their competitiveness, the present article analyzed the degree of connection of the eight Italian regions making up the southern macro-regional area of the country with the aim to assess if the network structure of the projects funded under the two latest FPs confirmed an agglomeration of innovation activities in the most advanced macro-areas (North and Center) or if they led to more widespread benefits for firms at the national level (Calignano, Quarta 2015).

The choice of SMEs as the object of study was determined by their absolute importance in the Italian economic fabric, which is composed of 99.9% of SMEs (ISTAT 2013a). Furthermore, the projects funded under the FPs were considered the ideal dataset especially for their intrinsic characteristic of transcalarity and the dynamic approach we adopted allowed us to project our findings in a long period (more than ten years) divided in two different lapses of time.

All these theoretical premises and methodological devices applied to the Italian case study enabled us to achieve several interesting findings. First of all, the northern regions and to a lesser extent the central regions dominated the innovation networks created by means of the links established throughout the two latest FPs both in terms of participation and collaborations. Furthermore, the agglomeration of innovation activities in the North and Center macro-regional areas is a phenomenon affecting all the considered geographical scales (intra-regional, extra-regional and transnational). Finally, the cluster analysis confirmed the absolute supremacy (as in the case of Lombardy, Emilia-Romagna and Lazio) and in any cases the central role (Tuscany and Piedmont in both FPs but also Liguria and Veneto in the only FP6) of those regions where industrial activities are traditionally mainly concentrated in Italy (Bagnasco 1977, Trigilia 1986, Scott 1988, Sforzi 1989, A'Hearn, Venables 2011). On the other hand, the figures related to the southern regions showed a very limited number of connections with a related weak knowledge exchange.

Supporting the findings of a previous study carried out in a similar vein (Calignano, Quarta 2015), the answer to the research question we asked in the introductory part of this

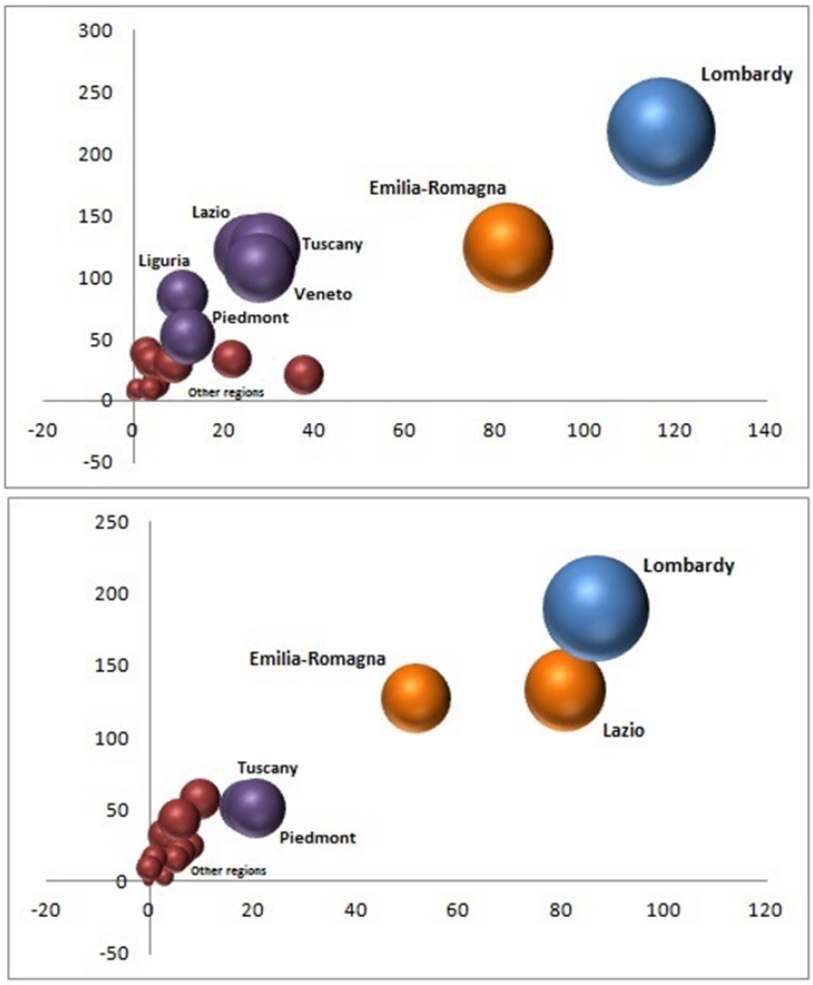


Figure 3: Italian regions clustered on the basis of their intra-regional, extra-regional and international links, FP6 (above) and FP7 (below). Methods: Hierarchical clustering; nearest neighbor method; Euclidean distance. Calculated from the Cordis dataset (European Commission 2015).

paper is that international networks involving various geographical scales (intra-regional, extra-regional and transnational) are hardly a way for SMEs located in peripheral and marginal area such as southern Italy to increase their competitiveness. They remained on the sidelines of the knowledge flows fostered by the EU innovation networks confirming the very weak level of innovation activities in the southern regions (ISTAT 2013b) as well as the long lasting disparities observed in the country (A'Hearn, Venables 2011).

In other words, all the figures revealed by the present paper demonstrated not only that the collaborations established by the Italian organizations at various geographical scales are influenced by the characteristics of the region in which they are located (i.e. dimension, geographical position, presence of PREs and qualified consultants, socio-economic and industrial context, etc.), but especially that the opportunities created by the so-called knowledge-based economy (Brinkley 2006) and the "open" model of innovation (Chesbrough 2003) – fostered by the research projects funded under the two latest FPs – did not enable the SMEs and PREs located in southern Italy to narrow remotely the gap with those ones located in the northern and more advanced regions of the country.

Based on several empirical evidences, our study provided reliable policy indications to the administrators and policymakers at the regional and national levels by implying the need of more direct (i.e. R&D financial support) and indirect (i.e. coordination/networking actions) support to the SMEs located in the southern regions. However, following the

theoretical premises outlined in the theoretical section (e.g. Bathelt et al. 2004, Gust-Bardon 2012), we argue that the Italian regional and national governments should consider especially the need to implement indirect policy measures based on coordination and networking activities aiming to enhance collaborations and partnerships – potentially leading to innovation – at various geographical scales.

Furthermore, the case study we illustrated in the present article has significant implications also for the other academics who are interested in analyzing the regional disparities in a country in terms of innovation and competitiveness. In fact, our study is easily reproducible and can be successfully applied in other countries with similar core-periphery dynamics (e.g. Greater London in the UK or Île-de-France in France) with the aim to compare the Italian framework, draw some wider influences and achieve further relevant results.

Finally, the methodological approach used in this study enabled us to reveal the knowledge flows and the related exchange in terms of knowledge involving the Italian SMEs and PREs at various geographical levels. These are aspects considered to be an essential prerequisite leading to innovation (European Commission 2013, Calignano, Quarta 2015).

However, our method based on descriptive statistics and cluster analysis did not allow us to investigate several other important aspects. Among these, the main motivations – besides the lack of financial resources allocated at the national level – which have pushed the Italian entrepreneurs and researchers to apply, the role played by other dimensions of proximity (Boschma 2005) in the building of the research groups throughout the FP6-SME and FP7-SME, and especially the impact of the FPs' collaborations in terms of actual innovation outputs and scientific and economic effects at the regional and national level (Calignano 2014).

For this reason, further studies carried out by adopting qualitative methods (e.g. in-depth interviews) are needed in order to answer these critical research questions and to offer a wider perspective.

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# Subjective Wellbeing Impacts of National and Subnational Fiscal Policies*

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**Abstract.** We study the association between fiscal policy and subjective wellbeing using fiscal data on 35 countries and 130 country-years, combined with over 170,000 people's subjective wellbeing scores. While past research has found that 'distortionary taxes' (e.g. income taxes) are associated with slow growth relative to 'non-distortionary' taxes (GST/VAT), we find that distortionary taxes are associated with higher levels of subjective wellbeing than non-distortionary taxes. This relationship holds when we control for macro-economic variables and country fixed effects. If this relationship is causal, it would offer an explanation as to why governments pursue these policies even when they harm economic growth. We find that richer people's subjective wellbeing is harmed less by indirect taxes than for people with lower incomes, while "unproductive expenditure" is associated with higher wellbeing for the middle class relative to others, possibly reflecting middle class capture. We see little evidence for differential effects of fiscal policy on people living in different sized settlements. Devolving a portion of expenditure to subnational government is associated with higher subjective wellbeing but devolving tax collection to subnational government is associated with monotonically lower subjective wellbeing.

**JEL classification:** D60, E62, H50, H70, O57

**Key words:** Subjective wellbeing, Fiscal policy, Decentralized government

## 1 Introduction

Beginning with Barro (1990), there have been a number of endogenous growth models that attempt to understand the impacts of fiscal policy on both growth and wellbeing. Many researchers have attempted to empirically test the model's predictions for economic growth, but economic growth is only a means to an end – the end being greater wellbeing. Despite

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this, far less attention has gone to testing the endogenous growth model's implications for wellbeing. We help to fill this gap by connecting the fiscal policy and growth literature to the subjective wellbeing (SWB) literature.

To the best of our knowledge this study is the first in the SWB literature to explicitly consider the government budget constraint, the first to consider SWB within the context of endogenous growth theory, one of few (including within the growth literature) to use the IMF's higher quality general (rather than central) government fiscal data, and the first to examine regional and subnational dimensions of the relationship of fiscal policies with subjective wellbeing.

While previous literature has argued that 'non-distortionary' indirect (sales) taxes are good for economic growth relative to 'distortionary' taxes, we find that distortionary taxes are associated with relatively higher levels of subjective wellbeing than are non-distortionary taxes. This result is robust to several different specifications. In addition, we find some indication that indirect taxes hurt the poor more than the rich, and we find the opposite relationship for distortionary taxation. As the model of Alesina, Rodrik (1994) predicts, we find evidence that productive expenditures benefit the poor relatively more than the rich. This result is not driven by people's political ideology, supporting the idea that fiscal policies affect wellbeing through effects on the real economy. "Unproductive expenditure" appears to benefit the middle class by more than it benefits the rich or poor, consistent with middle class capture as predicted by the median voter model.

We also study the impacts on subjective wellbeing of devolving government expenditure and taxation to subnational government. We find devolution of taxation is associated with lower subjective wellbeing, while partial devolution of expenditure is associated with higher subjective wellbeing. This is consistent with subnational authorities having better information on their constituents' wants and thus better ability to target resources. Taxation may be more simply administered by central government and the advantages to being better informed by constituents may be outweighed by economies of scale.

We find little variation when we interact fiscal policies with settlement size variables. Thus rural residents apparently have similar subjective wellbeing reactions to alternative fiscal policies as their urban counterparts.

We control for many unobservable and observable factors that affect fiscal policy and subjective wellbeing; importantly we control for country fixed effects, survey wave (i.e. time) fixed effects, personal characteristics, and country-specific, time-varying macroeconomic conditions. Our results can be interpreted causally if, aside from the variables that we already control for (including our macroeconomic controls), there are no other country-specific, time-varying factors that affect both fiscal policy and subjective wellbeing or any reverse causality from subjective wellbeing to fiscal policy. This is known as the parallel trends assumption[1]. We find it plausible that trends are parallel, especially after controlling for macro-economic variables, since we have not identified other country-specific, time-varying omitted factors that would bias our results. There is also no obvious reason why there would be reverse causality. However fiscal policy is chosen by countries (rather than randomly allocated) in part to reflect their changing circumstances, so we cannot completely eliminate the possibility that these decisions depend on some unobserved time-varying, country-specific variables that also affect subjective wellbeing[2]. We leave it to future research to analyze further the causal pathways that may underpin the relationships that we estimate.

Section 2 of the paper reviews the relevant theory. We discuss our data in Section 3, describe our methodology in Section 4, present our results in Section 5, and conclude in Section 6.

[1] In any study, even a randomised control trial, the counterfactual – in our case what would have happened to subjective wellbeing in the absence of fiscal policy change – is unobserved and hence the parallel trends assumption can never be directly tested. For a formal treatment of this issue see chapter 2 of Angrist, Pischke (2008).

[2] Clearly a randomised trial is not feasible for fiscal policy research.

## 2 Theoretical framework

### *2.1 The Barro framework*

Barro (1990) examined the role of fiscal policy within an endogenous growth framework – extending the previous work of Lucas (1988), Rebelo (1991), Romer (1986, 1988). Barro sets up a simple infinitely-lived representative agent model with lifetime utility, $U$, given by Equation (1).

$$U = \int_0^{\infty} u_t\left(c_t, h_t\right) e^{-\rho t}\, dt \tag{1}$$

where $\rho > 0$ is the rate of time preference and $u_t$ is instantaneous utility. Crucially instantaneous utility, $u_t$, depends on both private consumption, $c_t$, and government consumption services $h_t$. Because $h_t$ enters the utility function directly and not the production function it has been termed as an unproductive expenditure in the successive literature (e.g. Kneller et al. 1999, Bleaney et al. 2001, Angelopoulos et al. 2007). In addition to providing consumption services, the government also funds productive expenditures, $g_t$, that enter the production function alongside private capital ($k_t$):

$$y_t = \Phi(k_t, g_t) \tag{2}$$

where $y_t$ is aggregate output. As is standard in endogenous growth theory, $\Phi$ exhibits constant (or increasing) returns to scale. The full detail of the model is spelled out in Barro (1990). One of Barro's key results is that an increase in the share of output devoted to unproductive expenditures ($h_t/y_t$ in the notation above) reduces growth of output, capital and consumption, but potentially increases lifetime utility. As Barro and Sala-i-Martin put it in a later paper: "An increase in $\left[\frac{h_t}{y_t}\right]$ can be consistent with an increase in utility that accompanies a decrease in the growth rate" (Barro, Sala-i Martin 1992, 651)[3]. The growth slowdown occurs because the increase in income taxes lowers the private marginal product of capital, discouraging private investment; however, if the additional tax revenue is used to provide public services valued by households ($h_t$), overall utility may be raised.

The Barro model only includes income taxes and lump sum taxes. Labor supply is treated as perfectly inelastic and so consumption taxes are equivalent to a lump-sum tax. This has led to the potentially confusing convention of referring to consumption, sales, and value-added taxes (i.e. indirect taxes) as non-distortionary taxation in the subsequent empirical literature – again see, for example, Bleaney et al. (2001), Kneller et al. (1999), Angelopoulos et al. (2007). With endogenous labor supply, such consumption taxes are distortionary. With this qualification noted, we will continue with the terminology of previous authors so as to make our analysis comparable with theirs.

In the Barro model, with a representative agent, the socially optimal outcome cannot be obtained by income taxation as it distorts private incentives to save. Meanwhile lump-sum taxes produce a higher level of growth than income taxes but they too can fail to generate the socially optimal output level, as the optimum requires getting the government size just right[4]. With heterogeneous agents who value unproductive expenditures differently, the simple results from this model with regard to fiscal categories may no longer hold.

There have been many extensions to the basic Barro model. Misch et al. (2013) and also Baier, Glomm (2001) show that optimal fiscal policy depends on the degree of complementarity between $g$ and $k$: a high degree of complementarity results in a larger optimum government size and an optimal growth rate that is lower than the

[3] We have modified the notation to match that used above.

[4] Extra government expenditure on $g_t$ always increases each of the private marginal product of capital, savings and growth. If $g_t$ is financed through distortionary taxation, this acts as a countervailing force decreasing the private return to capital so that growth first increases and then decreases with $g_t$. In the case of lump-sum taxation there is no such countervailing force and so growth increases monotonically in $g_t$.

growth-maximizing one[5]. The importance of transitional dynamics is shown both by Baier, Glomm (2001) and Futagami et al. (1993). Turnovsky (2000) adds endogenous labor supply, demonstrating that an equilibrium growth path may not even exist. With endogenous labor-leisure trade-offs, consumption taxes become distortionary unlike in Barro (1990). This additional literature demonstrates that welfare maximizing fiscal policy is complex: the optimal policy setting depends on the exact model and is therefore an empirical question.

One last model, especially relevant to our work, is that of Alesina, Rodrik (1994). Alesina and Rodrik take the Barro framework and introduce variation in people's ownership of capital. In this model, the welfare of a pure capitalist – someone whose income is entirely from capital – is maximized when the growth rate is maximized, but all others prefer higher taxation and lower growth (and the lower their share of capital relative to labor income, the higher taxes they desire). The higher taxes are useful to laborers not through direct cash transfers, but because government-provided capital increases labor productivity. We test – and find some support for – the hypothesis that productive expenditure disproportionally benefits the poor[6].

### *2.2 Theory meets empirics*

Nijkamp, Poot (2004) conducted a meta-analysis of 93 empirical journal articles on the effects of fiscal policies on growth, finding mixed results for these effects. A key problem with many of the early papers that they reviewed is that the papers rarely gave due consideration to the government's budget constraint. For example, papers tested for the effects of taxation without controlling for how revenues are spent, or tested for the effects of government spending without controlling for how the revenues are raised. One exception is Bleaney et al. (2001), whose methodology we adapt for subjective wellbeing. We outline their approach in our methodology section.

### *2.3 SWB and fiscal policy literature*

There is only a small and recent literature on the effects of fiscal policies on subjective wellbeing. The results are mixed. For example, several papers look at the relationship between the size of government consumption and subjective wellbeing. Results include finding a negative relationship (Bjørnskov et al. 2007, Oishi et al. 2011), finding no relationship (Ram 2009), finding a positive relationship (Flavin et al. 2011, 2014), and finding an inverse U pattern (Hessami 2010). Other papers have looked at taxation with Flavin et al. (2011, 2014) finding higher taxation associated with higher SWB. Oishi et al. (2011) find more progressive tax systems are correlated with higher SWB. Veenhoven (2000) examines social security generosity and finds no relationship with SWB.

Most of these papers are cross sectional. Only Flavin et al. (2011, 2014) and Veenhoven (2000) estimate country fixed effects, despite the obvious importance of country effects for both SWB (e.g. through culture) and fiscal policy (again possibly through culture, or through circumstances like natural resource endowments)[7]. None of these papers takes into account the structure of taxation or how government consumption is financed, and none of these papers uses the high quality IMF general government data.

[5]This result holds even though Misch et al. (2013) did not include government consumption services, $h_t$. As Barro had already shown, the presence of these services also leads to a non-maximal optimal growth rate.

[6]One qualification is that our data is on relative income rank rather than capital wealth rank. However, a) higher income is correlated with higher wealth, and b) Alesina and Rodrik state: "When we use the term capital, for example, what we have in mind are all growth-producing assets, including physical capital, human capital, and proprietary technology. Labor, in turn, stands for unskilled labor." (Alesina, Rodrik 1994). In light of a) and b), low-income earners seem to be a reasonable proxy for their unskilled laborers, and high income earners seem a reasonable proxy for their capitalists.

[7]Even here the country panels are short, with Veenhoven (2000) only having two time periods to work with and hence just running a regression on the within country changes in SWB and social security generosity.

#### 2.3.1 SWB validation

SWB has become increasingly recognized as an important area of study as research has validated it as an informative measure of wellbeing. SWB is highly correlated in test-retest comparisons of the same individual a short time apart (e.g. see Diener et al. 2013). While some studies have shown that SWB can be influenced by seemingly arbitrary factors (e.g. Schwarz 1987), on average these vicissitudes will wash out in large samples such as ours. Many studies show a good correlation between SWB and other subjective and objective measures of wellbeing. For example, within a given country those who are richer are more satisfied with their lives, and across countries, developing countries are less satisfied than developed ones. Stevenson, Wolfers (2008) show that these cross-sectional relationships remain robust when considered in a time series context unlike the earlier findings of Easterlin (1974). Stevenson and Wolfers emphasize the log-linear rather than linear nature of the relationship between GDP per capita and SWB. They also emphasize that the positive point estimate for the relationship is robust even if its statistical significance is less so in some subsamples[8]. Helliwell, Huang (2008) show that life satisfaction is closely correlated with many of the World Bank's measures of good government. Di Tella et al. (2003) find that recessions lower SWB. Finally studies in other fields have found evidence that SWB correlates with other measures of people's welfare[9].

Several studies have found differences in rural versus urban SWB (Easterlin et al. 2011, Morrison 2011, Berry, Okulicz-Kozaryn 2011, 2009, Veenhoven 1994)[10]. For these reasons we include controls for settlement size and test whether relationships differ across large versus small settlements.

## 3 Data

### *3.1 Fiscal Variables*

The majority of our fiscal data is sourced from the IMF Government Finance Statistics database (IMF 2014), supplemented with OECD data where IMF data is missing (OECD 2014). Unlike almost all previous studies (in both the SWB and growth literature), we make use of general government as well as central government data: the former provides us with a more complete picture of a nation's fiscal policy settings, while the latter has better coverage. The use of both datasets together allows us to explore the SWB effects of decentralization of fiscal policy.

Following the Barro model, we split each of expenditure and taxation into two main categories: distortionary and non-distortionary taxation, and productive and unproductive expenditures. We also include two residual categories, "other revenue", $OR$, and "other expenditure", $OE$, plus the budget surplus ($BS$). Our taxonomy is the same as in much of the empirical growth literature; specifically we use the definitions of Bleaney et al. (2001) to make our results for the effects of fiscal policy on SWB directly comparable with their results for the effects on growth. These category definitions are described in detail in Table A.1. Broadly speaking, non-distortionary taxation, $NDT$, is defined as indirect taxes on goods and services (i.e. GST/VAT), while distortionary taxation, $DT$, is taxation on income, social security contributions, and property taxes. Productive expenditures, $PE$, include education, health, housing, transport, defense and general public services. Unproductive expenditures, $UE$, include social security and welfare, recreation and economic services. Each of these variables is expressed as a percentage of the country's GDP[11]. Summary statistics of these, and other country-level variables, can

[8] Easterlin et al. (2010) and Helliwell et al. (2012) are not convinced by these results with the latter pointing to the importance of the countries that are included in the analysis as well as which control variables are included. Clearly the debate is not yet settled.

[9] Studies in psychology have shown links between brain scans known to be associated with happiness and higher SWB (Urry et al. 2004). People who are more satisfied with their lives appear to live longer (Diener, Chan 2011). Early studies showed lower SWB predicted suicide (Helliwell 2007, Daly, Wilson 2009, Daly et al. 2013, Layard 2005), but a recent study by Case, Deaton (2015) found more mixed results.

[10] It appears that in developing countries people are more satisfied living in cities, while in developed countries there appears to be either no difference or the opposite relationship (Grimes, Reinhardt 2015).

[11] We use GDP data from the UN. The UN has several different nominal GDP series available reflecting

be found in Table A.2. More details about our data cleaning process can be found in the Appendix, as well as in our Stata code.

### *3.2 Subjective wellbeing and personal controls*

We use data on subjective wellbeing (SWB) from the World Values Survey (WVSA 2014) and the European Values Survey (EVS 2011). Subjective wellbeing is asked (in the local language) as:

> All things considered, how satisfied are you with your life as a whole these days? Please use this card to help with your answer. 'Dissatisfied' 1 2 3 4 5 6 7 8 9 10 'Satisfied'.

SWB is tightly distributed in all countries. Mean SWB is approximately 7.3 with a standard deviation of approximately 2 across all the individuals in our analysis. Figure A.1 shows the distribution of country means and standard deviations within different country-years,[12] while Figure A.2 provides a histogram of SWB scores. Because of SWB's tight distribution, even numerically small changes in SWB can be economically meaningful. For example Clark et al. (2008, 241) find that marriage increases SWB by about 0.3-0.4 after one year, and the largest shock they studied – widowhood – decreases SWB by about 1 unit. Across OECD countries the standard deviation is about 0.6, with a difference in average SWB of just 0.5 separating the 15th and 5th best position[13].

Both WVS and EVS include information on people's age, gender, education, settlement size, and political orientation. Table A.3 provides summary statistics for key variables. We include age in six categories[14], education in eight categories[15], and settlement size in four categories[16]. Political orientation and income are measured on a 10 point scale, entered in our regressions as categorical variables[17]. For each of these variables we include two extra categories for missing information: missing because the question was not asked in the survey, and missing for other reasons[18]. Finally we include a dummy variable to distinguish between the WVS and the EVS.

Donnelly, Pop-Eleches (2012) criticize the WVS and EVS measures of income. They point out that the income distributions associated with these 10 categories are not usually interpretable as deciles, as some researchers have interpreted them, and that the method used to record income varies. In the vast majority of surveys (210 out of 245), respondents are asked to place themselves in one of 10 income brackets (e.g. \$0-\$1,000, \$1,000–\$5000 etc.), where the brackets available were pre-determined by WVS/EVS, though 58 of these countries are missing documentation on the exact brackets used (Donnelly, Pop-Eleches 2012, 3). These brackets often do not generate uniform decile distributions of income. In other cases, respondents are asked to subjectively place themselves on a ten point scale

definitional issues and currency changes. Where possible we use one consistent series for each country in the same currency as the fiscal data. When this is not possible, we splice overlapping series to form one longer series.

[12] Figure A.1 should not be interpreted as showing a meaningful correlation between mean SWB in a country and that country's s.d. of SWB. Because SWB is bounded above, a DGP with a high mean will generate a disproportionate number of 10s and thus mechanically have a lower s.d. than a DGP with a mean of 5.

[13] Here we are comparing the (unweighted) average SWB of OECD countries using each country's latest measure of SWB from either the EVS or WVS.

[14] Under 19, 19–24, 25–34, 35–49, 50–64, and 65+.

[15] The categories, as per the world values data labels, are: "Inadequately completed elementary education", "Completed (compulsory) elementary education", "Incomplete secondary school: technical/vocational", "Complete secondary school: technical/vocational" "Incomplete secondary: university-preparation", "Complete secondary: university-preparation" "Some university without degree/Higher education", "University with degree/Higher education".

[16] Less than 5000, 5000–20,000/25,000, 20,000/25,000–100,000 and 100,000+. The reason for the blur between town populations of 20 and 25 thousand is because of changing survey definitions over time. Settlements in that interval are included in one category or the other, not both.

[17] In 1982 in the United States income was put on an 11 point scale, with 102 people coded as 11. We recode these people as 10.

[18] In practice it is common for several question to be omitted at once, so in these cases we cannot estimate separate coefficients for each missing category due to perfect multicollinearity among these categories. In this case only one coefficient is estimated capturing missing responses.

where 1 represents the first decile and 10 the highest. In such cases, most people respond with a middle number: for example 84% of Americans in the 2006 wave claim they are in one of the middle 5 deciles (deciles 3-7). Finally in some cases respondents are asked to write down their income, whereby WVS/EVS later recode it onto a ten point scale, in some cases to match pre-determined brackets, in other cases to perfectly split the data into ten equally populated deciles.

Because of these survey inconsistencies we interpret income purely as an ordinal variable within a given country year: i.e. if somebody is on a higher income step than someone else in the same country-year they likely earn more, but we do not know the cardinal relationships between categories.

### *3.3 Macroeconomic controls*

In most specifications we include controls for real PPP-adjusted GDP per capita (current and lagged three years), unemployment, investment, and inflation. We calculate real GDP per capita as real PPP-adjusted GDP divided by population, with both figures coming from the Penn World Tables, version 8.1 (Feenstra et al. 2015) except in the case of 2012 data, where we use data from the World Bank (The World Bank 2015b)[19]. Our primary source of data on unemployment is from the Annual Macro Economics Database (European Commission 2015). For countries where we do not have AMECO data we use the World Bank development indicators data, (The World Bank 2015c) spliced, where necessary, with UN unemployment data (The United Nations 2015)[20]. We source inflation data for all but three countries from the World Bank development indicators[21]. All investment data is from the World Bank development indicators (The World Bank 2015b,c)[22]. Table A.4 lists the countries used in each of our regressions.

## 4 Methodology

Equation (3) illustrates our baseline equation. We estimate subjective wellbeing for individual $i$ in country $c$ at time $t$ as a function of our fiscal variables, $\boldsymbol{F}$, a vector of personal controls, $\boldsymbol{X}$, a vector of macro controls, $\boldsymbol{M}$, country fixed effects, $\lambda_c$, and survey wave (time) fixed effects, $\lambda_w$.

$$\begin{aligned} SWB_{i,c,t} &= \beta_0 + \boldsymbol{\beta}_F\boldsymbol{F} + \boldsymbol{\beta}_2\boldsymbol{X} + \boldsymbol{\beta}_3\boldsymbol{M} + \lambda_w + \lambda_c + \epsilon \qquad (3) \\ \text{where} & \\ \boldsymbol{\beta}_F\boldsymbol{F} &= \beta_{NDT}NDT + \beta_{DT}DT + \beta_{PE}PE + \beta_{UE}UE + \beta_{OR}OR + \beta_{OE}OE \end{aligned}$$

with the budget surplus $BS$ omitted to avoid perfect multicollinearity. In other specifications we make some modifications to Equation (3), e.g. removing the macro controls, including an interaction of our fiscal variables with income and political affiliation, and including the proportion of each fiscal category which is spent subnationally.

Our analysis includes countries only if we observe them in more than one year. This allows us to estimate country fixed effects $\lambda_c$. Researchers have worried about whether the SWB question is understood the same way across different countries. Separately,

[19] This is because the Penn World Tables v8.1 do not extend to 2012. The World Bank data is spliced multiplicatively with the PWT data.

[20] The splicing occurs when the World Bank data do not go back far enough. The splicing method we use here differs from the multiplicative method we use to splice GDP together. For unemployment our splice method is: First, find the first year the World Bank and United Nation's series overlap. Second, calculate the difference between these two series at this point, denoted U_WB-U_UN. Third, for all points earlier than this overlap, where World Bank data is missing, we define unemployment to be the United Nations rate plus U_WB-U_UN.

[21] We use OECD inflation data for Chile and the United Kingdom, and we use FRED data (which is itself originally from the World Bank) for Argentina, accessed on 10 November 2015 (The World Bank 2015a).

[22] The investment data ("Gross capital formation as percent of GDP" series code = ne.gdi.totl.zs) is the 14th of October 2015 version of the World Bank development indicators (accessed on the 12th of November 2015), except for Lithuania, where we use the 14 April 2015 release of the indicators (accessed 26 June 2015) because the October release does not include data for Lithuania prior to 2004.

different cultures may have different average levels of subjective wellbeing. In both cases, failure to control for these could bias our estimate of $\boldsymbol{\beta}_F$. Country fixed effects allow us to control for, among other things, constant cultural effects over time[23].

In addition to country fixed effects, we control for survey wave fixed effects, $\lambda_w$. The survey waves are: 1981-84, 1989-93, 1994-98, 1999-04, 2005-09, 2010-12[24]. These are important as they allow us to control for any changes in survey practices across survey wave. For example the order of question and types of questions elsewhere in the survey can change, possibly affecting people's responses. The wave fixed effects will also pick up global shocks to macro and other variables (for example global recessions such as the global financial crisis which may affect both SWB and our fiscal variables).

The government's budget constraint requires that in each year all taxes be spent or saved, and that all expenditure be funded by taxation or borrowing. Formally:

$$DT_t + NDT_t + OR_t = PE_t + UE_t + OE_t + BS_t \tag{4}$$

As Bleaney et al. (2001) emphasize, it is vital to recognise the government's budget constraint when analysing the effects of fiscal policy. Fiscal policy does not occur in a vacuum: expenditure must be financed, and taxes must be spent or saved. If one looks at a variable in isolation, say productive expenditure, then one cannot obtain a clear picture of its impact on wellbeing because its effect on wellbeing will depend on whether it is funded from reducing unproductive expenditures, increasing distortionary or non-distortionary taxes, or by borrowing the funds.

Because of the perfect collinearity described in Equation (4) one category must be omitted when we estimate Equation (3). The coefficients on each fiscal variable are then interpreted as the effect of increasing that variable by one unit financed by changing the omitted category. In our regressions we omit the budget surplus, so that for an increase in an expenditure variable the assumption is that the surplus is reduced, while for taxation variables the assumption is that the surplus is increased.

After estimating Equation (3) with the surplus omitted, it is trivial to compute the associations relative to an alternative financing assumption. One simply adds or subtracts the coefficients estimated in Equation (3); for example, to find the effect of increasing $PE$ by one percent of GDP funded by increasing $DT$ one should add $\widehat{\beta_{PE}}$ and $\widehat{\beta_{DT}}$. If the increase in $PE$ were instead funded by reducing $UE$, then one should subtract $\widehat{\beta_{UE}}$ from $\widehat{\beta_{PE}}$.

The effects of fiscal policies could be nonlinear. For example, perhaps a small amount of non-distortionary taxation is beneficial for SWB, while too much is detrimental. One way of dealing with such nonlinearities would be to include polynomials into the specification. However, given the complication of the government's budget constraint, marginal effects would then become difficult to interpret. Whether, say, more distortionary taxation funded from a reduction in non-distortionary taxation was beneficial for SWB would depend on the existing amount of *both* distortionary and non-distortionary taxation. In addition to the issues of interpretation, we are wary of overfitting the model, and picking up outliers, if we were to estimate such nonlinearities. The same problems present themselves for the fiscal policy and growth literature (discussed above) and we are not aware of papers that deal with both the government's budget constraint and nonlinearities in fiscal policy. Given the difficulties in adequately dealing with these issues we leave analysis of the impacts of such nonlinearities for separate research.

All our equations are estimated using OLS with two-way fixed effects and a suite of personal and macroeconomic controls. As discussed above, fiscal policies are chosen, rather than being randomly assigned. One can think of isolated cases where a shock to most individuals' wellbeing is correlated with shocks to one or more fiscal variables. For instance, even in the absence of any macroeconomic effects, a terrorist attack may lower SWB while raising defense expenditure. Intuitively, however, such examples appear to be isolated, especially once any conduits through macroeconomic conditions are controlled for.

[23] Other factors controlled for by fixed effects include, inter alia, climate and geography.

[24] We prefer wave effects (i.e. groups of years) to the finer grained year effects as we sometimes only observe one or two countries' SWB in a given year. Including year effects would effectively remove these observations from our analysis.

At a practical level randomization of fiscal policy is off the table, and suitable instruments for fiscal policy variables are hard to come by since most variables that are correlated with fiscal policy could also directly affect SWB. Even if one could find instruments that satisfy the exclusion restriction, they would need to be strong, and no strong instruments present themselves. While our study is at least as well identified as the fiscal policy and growth literature, we still speak of associations or relationships rather than causal connections because we cannot definitively rule out violations of parallel trends.

## 5 Results

As emphasized in the previous section, when estimating the effects of fiscal categories on wellbeing (or growth), none of the fiscal coefficients can be interpreted in isolation. To aid comparisons of coefficients with each other, we plot the estimated coefficients graphically together with their 90% confidence intervals. Detailed regression tables for Figure 1 and Figure 5 can be found in the appendix[25].

### *5.1 Baseline Results*

Figure 1 plots the coefficients from four different regressions. The top set of results (i.e. the first four listed fiscal categories) uses the general government data as our fiscal variables, $\boldsymbol{F}$, whilst the bottom set of results use the central government data. A coefficient of zero implies that an increase in that variable has the same effect on SWB as the omitted category – the surplus. For each regression, we present results without macroeconomic controls (the upper of each pair) and with the inclusion of macroeconomic controls to show whether results are sensitive to their inclusion. All regressions contain the controls for personal characteristics.

In all four regressions, distortionary taxes are associated with higher subjective wellbeing than non-distortionary taxation, and productive expenditures are associated with higher subjective wellbeing than unproductive expenditures. Adding macro controls makes very little difference to the results: non-distortionary taxation appears to be worse for SWB when macro controls are added to the general government regression, but the effect is imprecisely estimated (as evidenced by the wide confidence intervals), and the point estimate hardly changes when macro controls are added to the central government regression.

The magnitude of the coefficients shows the SWB effect of a 1 percentage point-sized change in the fiscal variable (funded by changing the surplus) as a proportion of GDP. The differences between different tax and expenditure estimates are economically meaningful. For example, reducing distortionary taxation by 10 percent of GDP funded by a same sized rise in non-distortionary taxation is associated with an approximate 0.6 unit rise in SWB, about 25% of a standard deviation. This effect is larger than the (transitory) effect of getting married found in Clark et al. (2008), and it is enough to move a country's subjective wellbeing rank from around 15th out of the 34 OECD countries to about 5th.

### *5.2 Differential effects of fiscal policy*

We examine whether the impacts of fiscal policy on SWB vary according to income and political persuasion. Noting the similarity of results above using central and general government definitions, and given the larger sample size afforded by the central government dataset, we estimate these equations based on the central government data. All results in this section include all macro and personal controls.

#### 5.2.1 Income

With progressive income taxes, higher income earners pay a higher percentage of their income in income tax than low income earners, while under consumption taxes poorer people pay a higher percentage of their income than high income earners (assuming that

[25] The non-parametric estimates in Figures 2-4 have too many coefficients to be usefully presented in a table; the coefficients and $p$-values for the linear interaction terms are shown within the figures.

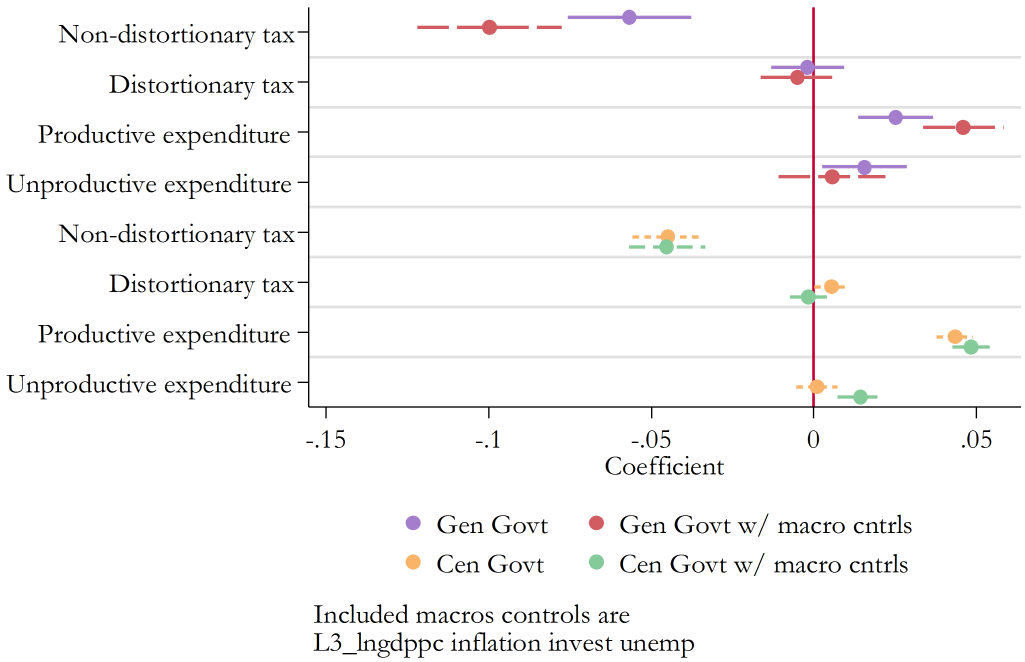


Figure 1: Baseline estimates (90% CI)

poorer people save less). Given these differences in incidence, we explore whether people at different parts of the income spectrum have different SWB responses to the various fiscal categories.

We examine these effects in two ways. First, we treat income as a continuous variable and interact it linearly with each fiscal category. Second, we treat income as a categorical variable and interact each income category with each of the four main fiscal policies $\boldsymbol{F}_M$ as in equation (5):[26]

$$SWB_{i,c,t} = \beta_0 + \boldsymbol{\beta}_2\boldsymbol{X} + \boldsymbol{\beta}_3\boldsymbol{M} + \lambda_w + \lambda_c + \lambda_{inc} + \boldsymbol{\beta}_F\boldsymbol{F} + \boldsymbol{\beta}_{int}(\lambda_{inc} \times \boldsymbol{F}_M) + \epsilon \quad (5)$$

This non-parametric approach does not impose any functional form assumption, but has the drawback of decreasing the precision of our estimates.

Figure 2 plots the marginal effects of our fiscal variables from both specifications across the ten income ranks[27]. The dashed lines present the marginal effects of the linearly interacted variable, with the slope estimate and its associated $p$-value displayed beneath each graph. The solid line links the non-parametric estimates (with associated 90% confidence intervals). As expected, our results indicate that distortionary taxation has a more negative effect for higher income earners, and non-distortionary taxation has a more negative effect on lower income earners. Productive expenditure also appears to be favored by poorer individuals, consistent with Alesina, Rodrik (1994), where productive expenditure especially improves the welfare of unskilled laborers (see Section 2).

The results for unproductive expenditures, which mainly comprises social welfare spending, is found to have most benefit for the middle class and least benefit for poorer people. Indeed, the point estimate for the poorest people is negative. This result is consistent with middle class capture, as in median voter models[28]. An alternative explanation is that this result could reflect the countercyclical nature of unproductive expenditures combined with an assumption that business cycles affect the poor the most

[26] Recall, as discussed in Section 3.2, that our income variable is an ordinal measure of a person's relative income within the country and year that they were surveyed.

[27] The omitted category is again the surplus. We do not interact the (residual) other revenue or other expenditure categories, though we do continue to include them as controls without interactions.

[28] In median voter models the median voter determines policy. See Hotelling (1929), Black (1948), and Bowen (1943) for the original papers developing the theory. See the section on majority voting in chapter 6 of Stiglitz (1988) for a modern textbook introduction.

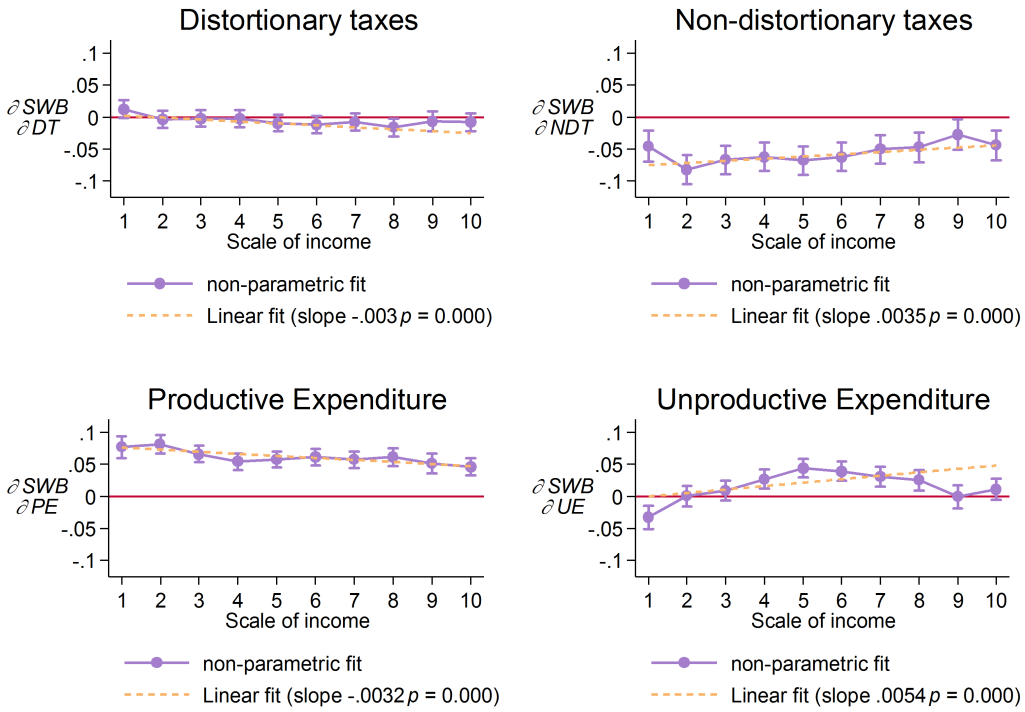


Figure 2: Marginal effects by income group (90% CI)

and the middle class the least. To minimize this potential source of bias, our estimates include controls for unemployment, investment, inflation, current GDP and lagged GDP, so this alternative explanation would require that these variables do not sufficiently control for the business cycle.

#### 5.2.2 Political orientation

It is possible that fiscal policy affects utility directly through political preferences (ideologies) instead of through the fiscal policy's influence on the real economy ($h$ and $c$). We examine whether this may be the case. If such a phenomenon were driving our results, we would expect to see different effects of fiscal policy depending on political orientation. We repeat the same interaction procedures as described above for income, but replacing income with people's political orientation. As can be seen from Figure 3, we find the same effect of fiscal policies for people of different political orientations: the slope estimates are smaller than for the income interactions and none are significant at the 5% level (though the interaction with distortionary taxation is significant at the 10% level), while the non-parametric fits reveal no discernible trend.

### *5.3 Regions: Heterogeneous settlement size and subnational effects*

Our prior results all control for the settlement size of the individual respondent but do not allow the fiscal impacts to vary by settlement size, nor do they test whether national versus subnational fiscal policies have differential effects on SWB. In addition, fiscal policy may affect wealthier countries differently to less wealthy ones and this effect may differ by town size. Here we test each of these region-related aspects.

#### 5.3.1 Settlement size and country income

We investigate whether fiscal policies affect people living in different sized towns and cities in different ways. To do so, we interact the size of a person's settlement with the fiscal policy variables. We test whether these effects may differ according to the wealth of countries by creating a dummy variable (richer/poorer), which splits our sample roughly in half, based on 1990 GDP per capita (using PWT 8.1 definitions of GDP and

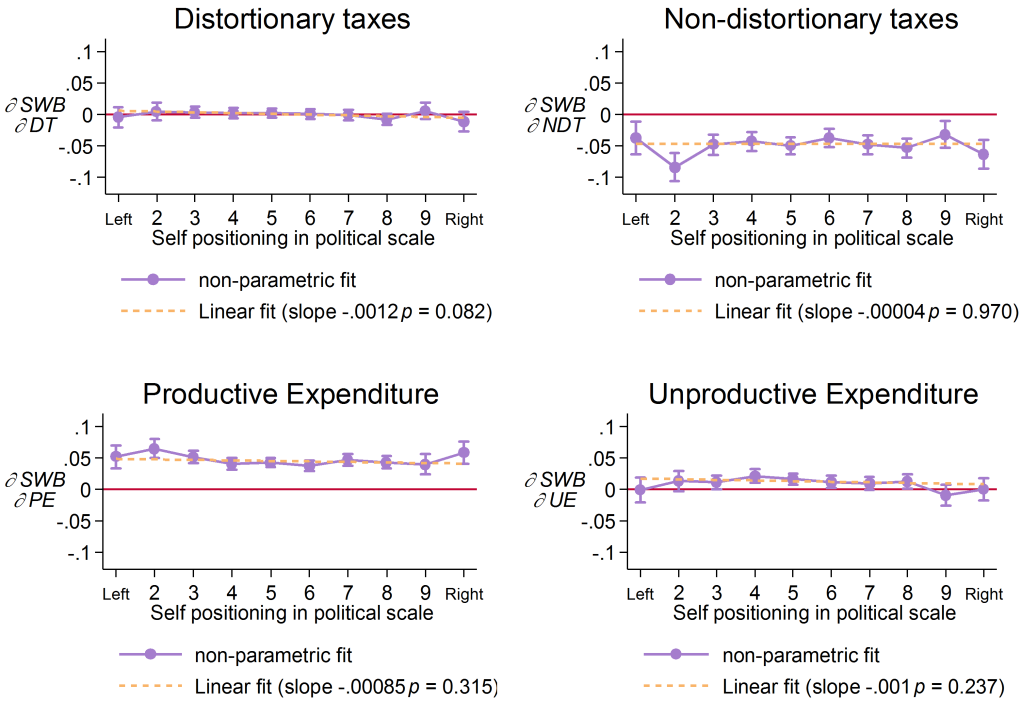


Figure 3: Marginal effects by self-expressed political orientation (90% CI)

population). We stress here that our sample does not include developing countries, and that generally the 'poorer' countries are at least middle income[29]. We then interact our rich/poor variable with both fiscal policy and town size. This allows the effect of each fiscal variable to differ across the 8 different combinations of country wealth and town size.

The results (again using the central government definitions) are presented in Figure 4. (Linear interactions are not included given the non-linear definitions of settlement size in the data.)

Productive expenditure appears to be more beneficial for SWB in poorer countries, while there is some evidence that non-distortionary taxes are more detrimental in poorer countries. Distortionary taxation appears to have similar effects in both rich and poor countries. Unproductive expenditures have a similar effect on SWB in both rich and poor countries, with only weak evidence for more positive effects in richer countries.

Turning to differences in fiscal policy's influence across town size (i.e. the slope of the lines in Figure 4) we find little variation, with the 90% confidence intervals largely overlapping. There is, perhaps, some evidence for differences in effects of distortionary taxes, and productive expenditure in cities with more than 100,000 people ('large cities'), but care should be taken here for several reasons. Firstly, the results differ for wealthier and less wealthy countries; in richer countries the effects of productive expenditure deteriorate in the larger settlements, while in poorer countries the effects of productive expenditure improve in larger settlements. *A priori*, we have no strong reason to suppose this. Relatedly, given the multiple comparisons being made here, deviations like this may occur from chance alone (i.e. a false positive). Finally, the relative incomes of people within a country (rather than the across country differences) are correlated with settlement size, so it is possible that the estimated association found here is driven not by the size of the town *per se* but by the differences in incomes of the people living in these towns.

[29] 'Poorer' countries in our sample are: Chile, Cyprus, Czech Republic, Estonia, Greece, Hungary, Ireland, Lithuania, Malta, Poland, Portugal, Slovenia, Spain, and the Ukraine. Richer countries in our sample are: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Luxembourg, Netherlands, Norway, Sweden, Switzerland, United Kingdom, and the United States.

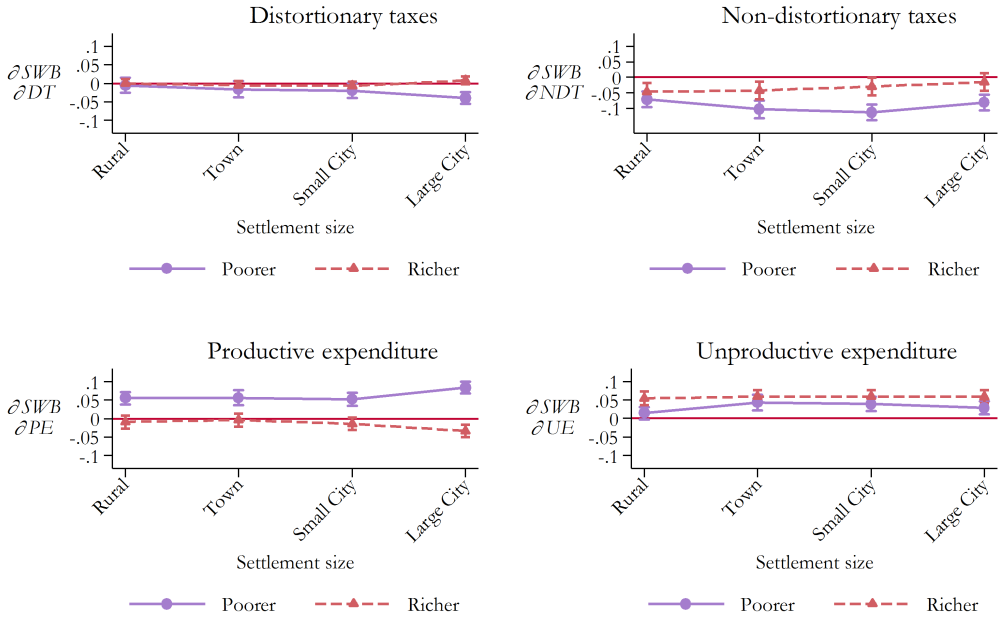


Figure 4: Marginal effects by settlement size and richer/poorer countries (90% CI)

### 5.3.2 Devolution of fiscal policy to subnational government

We examine the relationship to wellbeing of differences in the degree to which fiscal expenditures and revenues are centralized or decentralized to subnational government. Subnational government is taken to comprise all levels of government below central government (i.e. including both state and municipal governments).

For each fiscal category, we calculated the proportion of general government taxation or expenditure that occurs at the subnational level. The proportion that is subnational is defined as $1 - \frac{var_{CG}}{var_{GG}}$, where $var_{CG}$ is the amount of the fiscal variable reported at the central government level and $var_{GG}$ the amount reported at the general government level. We investigated other definitions but consider this definition to be the most reliable of those available. For example, we had measures of local and regional government fiscal variables from an alternative data source, which we added to form an estimate of the subnational component, $var_{SN}$, allowing us to estimate the proportion subnational as $\frac{var_{SN}}{var_{CG}+var_{SN}}$ for each fiscal variable. Unfortunately, these estimates of subnational government were often implausible (most probably due to double counting of taxes and expenditures in the subnational categories) and, as a result, the corresponding results differ to those presented below[30]. The measure of subnational government that we use has deficiencies as a result of drawing data from different sources that may have slightly different fiscal definitions to each other (and which could include some double counting), explaining why we have isolated country examples where central government is greater than general government within a particular fiscal category. For these reasons, while we have used the best available data, our results in this section should be interpreted with some caution.

We estimated Equation (6), being our baseline equation modified to include terms for the proportion of each variable that is subnational (denoted by the vector $\boldsymbol{S}$). A non-linear relationship is implied if the optimal level of subnational government is neither 0% nor 100%. We find that a cubic specification best fits the data[31]. Hence, our baseline

[30] Our definition of subnational government, $var_{SN} = 1 - \frac{var_{CG}}{var_{GG}}$, could also be affected by double counting in the central government variable (i.e $var_{CG}$ is overestimated due to part of $var_{CG}$ truly being subnational). To the extent this is the case it means our estimate of subnational government is too low, and hence our coefficients on $var_{SN}$ too large in absolute magnitude.

[31] In addition to the cubic specification we estimated the equation with a quadratic specification, as well as linearly. The Akaike criterion, Bayesian information criterion, and adjusted R-square all preferred the cubic specification (see Table A.6). All of the cubic terms were significant at the 1% level except for the coefficient on subnational non-distortionary tax, which was significant at the 10% level.

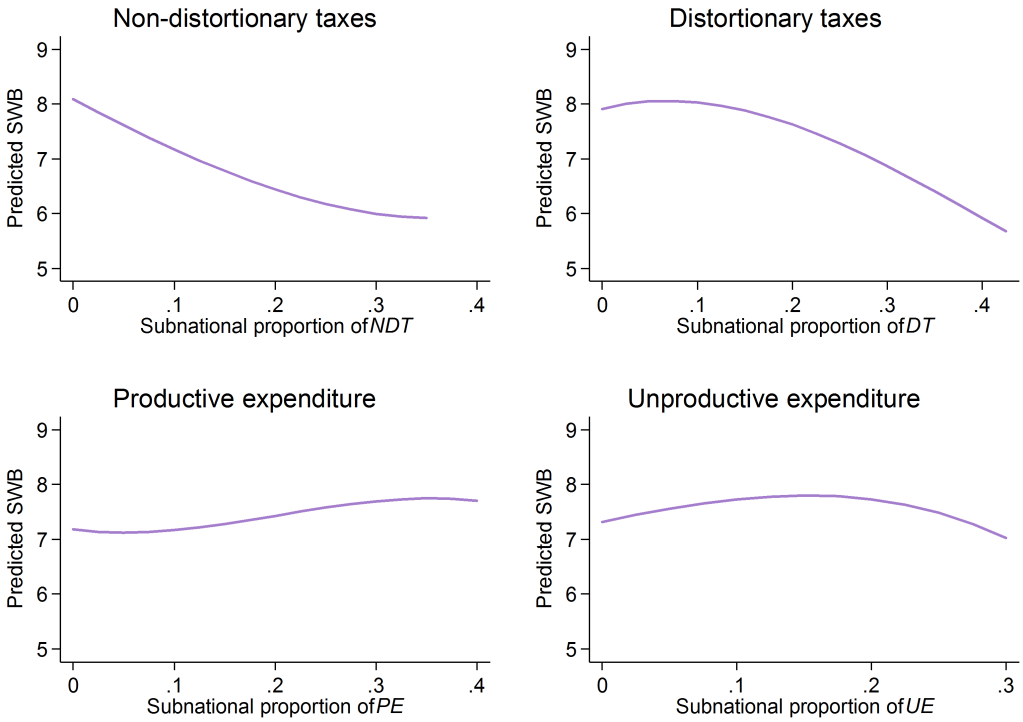


Figure 5: Predicted effects of varying subnational fiscal proportions

estimation includes $\boldsymbol{S}^2$ and $\boldsymbol{S}^3$, vectors whose elements are the squares and cubes of the elements in $\boldsymbol{S}$.

$$SWB_{i,c,t} = \beta_0 + \boldsymbol{\beta}_1\boldsymbol{F} + \boldsymbol{\alpha}_1\boldsymbol{S} + \boldsymbol{\alpha}_2\boldsymbol{S}^2 + \boldsymbol{\alpha}_3\boldsymbol{S}^3 + \boldsymbol{\beta}_2\boldsymbol{X} + \boldsymbol{\beta}_3\boldsymbol{M} + \lambda_w + \lambda_c + \epsilon \quad (6)$$

Figure 5 plots the predicted values from the regression in (6), as each subnational proportion variable is varied between 0 and its 90th percentile in the regression sample. For each plot, all other variables are evaluated at their sample means.

The results suggest that taxation is best done centrally, while expenditure is best done by a combination of central and subnational government. This is consistent with economies of scale being important for revenue raising, and with local knowledge being important for expenditure. In other words, it appears optimal to keep taxation systems simple and centralized, and to allow fiscal expenditures some latitude to reflect local complexities.

## 6 Conclusions

Economic growth is not an end in itself, but instead is a means to greater utility or wellbeing. While the empirical literature on the effects of fiscal policy has hitherto focussed on GDP growth, we have focused on subjective wellbeing – an important measure of people's overall wellbeing. Our evidence on the relationships between fiscal policy and subjective wellbeing can feed into the decisions of policymakers who have policy goals that extend beyond economic growth.

The small amount of prior literature relating to fiscal policy and wellbeing has focused on the overall size of government, without addressing how government is financed. We adapt the methodology used in the (Bleaney et al. 2001) GDP growth study to explicitly control for the government budget constraint, estimating the relationship between wellbeing and taxation and expenditure shares. In line with the Barro endogenous growth framework and the approach taken by Bleaney, Gemmell and Kneller, we distinguish between the effects of four broad fiscal categories: "productive expenditure", or government-provided capital; "unproductive expenditure", or government-provided

consumption; "distortionary taxation" such as income taxes and social security contributions; and "non-distortionary taxation" such as VAT. We retain their definitions of these variables to enable comparisons with the prior literature. This study is, to the best of our knowledge, the first in the SWB literature to explicitly consider the government budget constraint, the first to consider SWB within the context of endogenous growth theory, and the first to examine regional and subnational dimensions of the relationship of fiscal policies with subjective wellbeing.

We use fiscal data from the IMF Government Finance Statistics and the OECD, for 35 countries and 130 country-years. Unlike almost all previous studies, we make use of general government as well as central government data. We combine our fiscal data with over 170,000 individual responses from the World Values Survey and European Values Study and with macroeconomic data from various sources.

We find a number of important relationships, even after including country fixed effects and a suite of macroeconomic and personal controls. First, we find a positive association between SWB and a decrease in non-distortionary taxes funded by an increase in distortionary taxation. Second, we find a positive association between SWB and an increase in productive expenditures funded by a decrease in unproductive expenditures. While we find no material differences across the political spectrum, we do find differences in associations across people of different incomes: Richer people are hurt more by distortionary taxation and less by non-distortionary taxation than poorer people. They also benefit by less than poorer people do from productive expenditures. The middle class appear to benefit the most from unproductive expenditures, consistent with a theory of middle class capture.

In examining regional issues, we find no material differences in the effects of fiscal policy across people living in different-sized settlements. However, we do uncover important patterns related to subnational versus central government fiscal policies. Most notably, we find a positive association, up to a point, between SWB and an increase in the share of expenditures that are spent subnationally. Additionally, we find a negative association between SWB and an increase in the share of tax revenue raised subnationally. Thus our findings support taxation being a central government function while fiscal expenditures appear to be best provided by a combination of central and subnational governments.

Our estimates control for personal characteristics of the over 170,000 individuals in our sample and control for a suite of macroeconomic circumstances that could independently affect wellbeing. We see no strong reason to expect material reverse causality from subjective wellbeing to fiscal policies or to expect any major sources of omitted variables bias, especially given that we have controlled for macroeconomic conditions. Nevertheless, future research could further examine the extent to which the relationships that we establish are causal and examine the causal pathways through which these relationships act. In particular, our findings regarding the optimal roles for subnational versus central government fiscal policies could prove a fruitful area for further research with an emphasis on uncovering particular categories of expenditures (and taxes) that are best retained at the central government level and those that are best devolved to subnational government.

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# A Appendix

## *A.1 Data*

We cleaned the IMF and OECD fiscal data to remove unreliable observations. We explain the most important parts of this cleaning here. Full detail can be found in our code which we have placed on the Motu website (www.motu.org.nz).

### A.1.1 Modern vs. Historical GFS

The IMF data from 1972 – 1989 is classified using the 'historical' 1986 definitions while the data from 1990 onwards are classified using the 'modern' 2001 format. We followed the IMF's guidelines for reclassifying data from 1986 to 2001 format. The key differences between the historical and modern format is that the historical outlays include gross purchases of capital assets in the relevant COFOG category, while modern only reports net purchases of capital in the functional categories. There is no way to convert 1986 expenditure data exactly to the 2001 definition because there is no information to allocate sales of capital assets to the various functions. There are also issues with how revenues of government enterprises and social contributions for government employees are reported. Finally environmental protection is a new category in GFS2001.

In addition the modern IMF GFS statistics include both accrual and cash based definitions of fiscal variables – with neither versions of the variables offering complete coverage. For this reason we use the cash data where possible, and then for the remainder we use the accrual data – modified to be more comparable to the cash data. The modification process is as follows: first we look at cases where we have both the accrual and cash data. Then we calculate the 10% trimmed mean of the ratio of cash to accrual (separately for each variable). Finally the accrual data is multiplied by this (variable specific) ratio.

The OECD data and IMF fiscal data appear to be compiled differently. To make them comparable we use the same method as we did for converting accrual to cash data.

### A.1.2 Dropping of countries with unreliable data

We inspected the fiscal data for all countries in our analysis. Where the data looked unreliable that country was dropped – at least for the period where the data looked unstable. In particular we included most countries where none of their key fiscal variables changed by more than 7 percentage points since last observed (usually the previous year). For countries that had changes larger than 7 percentage points we inspected to see if these changes plausibly reflected real changes rather than just questionable data. For example, our data showed Iceland's unproductive expenditures increased by over 10 percentage points of GDP in 2008, but given their massive banking failure that year, such variation is to be expected, and so Iceland is included in our analysis. On the hand, the 15 percentage point increase in NZ productive expenditure as a share of GDP from 2007 to 2009 is judged to be inaccurate data, and so New Zealand is excluded from our analysis. We limit our focus to high and middle income countries excluding low income countries such as India.

## *A.2 Tables and Figures*

Table A.1: Fiscal variable classifications

| Symbol | THEORETICAL CATEGORY | IMF FUNCTIONAL CATEGORY |
|---|---|---|
| DT | Distortionary taxation | Taxation on income and profit<br>Social security contributions<br>Taxation on payroll and manpower<br>Taxation on property |
| $NDT$ | Non-distortionary taxation | Taxes on goods and services |
| PE | Productive expenditures | General public services<br>Defence<br>Education<br>Health<br>Housing<br>Transport and communication |
| UE | Unproductive expenditures | Social security and welfare<br>Recreation<br>Economic services |
| $OR$ | Other revenues | |
| $OE$ | Other expenditure | |
| $BS$ | Budget surplus | We define this as the residual:<br>$DT_t + NDT_t + OR_t - PE_t -$<br>$UE_t - OE_t \equiv BS_t$ |

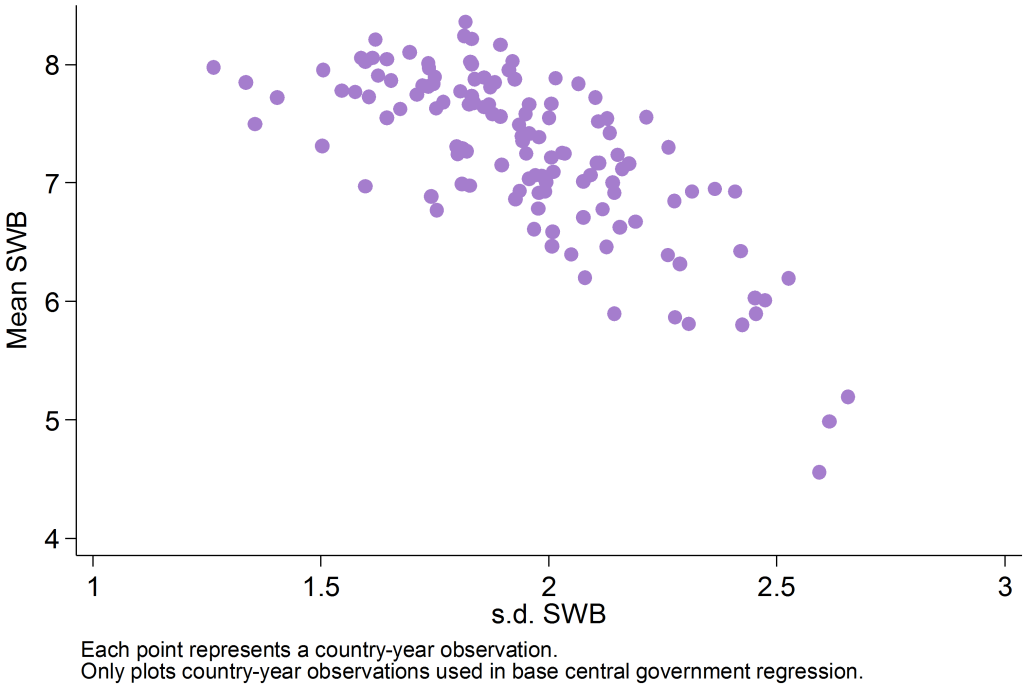


Figure A.1: Scatter plot of mean SWB vs. s.d. SWB

Table A.2: Country-level variable summary statistics

| | Mean | Median | s.d | Min | Max | Number country-year obs |
|---|---|---|---|---|---|---|
| *General Government definitions** | | | | | | |
| Distortionary taxation | 24.91 | 24.8 | 5.92 | 7.36 | 37.62 | 79 |
| Non-distortionary taxation | 10.74 | 11.26 | 2.73 | 4.01 | 15.91 | 79 |
| Productive expenditures | 21.6 | 22.07 | 3.58 | 10.37 | 29.79 | 79 |
| Unproductive expenditures | 19.39 | 19.94 | 4.88 | 3.09 | 29.44 | 79 |
| Other revenues | 7.05 | 6.62 | 2.79 | 3.54 | 18.37 | 79 |
| Other expenditures | 0.12 | 0.08 | 0.49 | -0.62 | 3.32 | 79 |
| *Central Government definition*** | | | | | | |
| Distortionary taxation | 18.46 | 19.06 | 6.05 | 4.3 | 32.1 | 129 |
| Non-distortionary taxation | 9.58 | 10.58 | 3.79 | 0.61 | 18.74 | 129 |
| Productive expenditures | 17.14 | 16.65 | 4.85 | 5.05 | 28.47 | 129 |
| Unproductive expenditures | 17.04 | 17.38 | 5.23 | 3.09 | 31.16 | 129 |
| Other revenues | 4.63 | 4.16 | 2.9 | 1.36 | 23.12 | 129 |
| Other expenditures | -0.12 | 0 | 0.95 | -6.11 | 2.01 | 129 |
| *Macro controls*** | | | | | | |
| Inflation (% p.a.) | 5.87 | 3.27 | 9.14 | -1.82 | 83.99 | 129 |
| Investment | 23.48 | 23.42 | 3.64 | 14.64 | 32.69 | 128 |
| Unemployment (% p.a.) | 7.58 | 7.1 | 3.73 | 1.7 | 21.4 | 127 |
| *Proportion of fiscal variable that is subnational government**** | | | | | | |
| Non-distortionary taxation | 0.12 | 0.05 | 0.17 | -0.05 | 0.62 | 69 |
| Distortionary taxation | 0.19 | 0.15 | 0.16 | 0 | 0.54 | 69 |
| Productive expenditures | 0.15 | 0.13 | 0.18 | -0.18 | 0.64 | 69 |
| Unproductive expenditures | 0.13 | 0.13 | 0.14 | -0.31 | 0.42 | 69 |

*Notes*: The fiscal variables (first two panels) are expressed as a percentage of GDP. Investment is also expressed as a percentage of GDP. All figures rounded to 2 d.p. Figures are based on the country-years that are included in (certain) regressions. * Based on general government sample. ** Based on central government sample. *** Based on proportion government sample.

Table A.3: Individual level variables summary statistics

| | mean | median | sd | min | max | N |
|---|---|---|---|---|---|---|
| *Subjective wellbeing* | | | | | | |
| SWB - Central government sample | 7.26 | 8 | 2.05 | 1 | 10 | 110,659 |
| SWB - General government sample | 7.26 | 8 | 2.07 | 1 | 10 | 171,804 |
| SWB - Proportion subnational sample | 7.33 | 8 | 1.98 | 1 | 10 | 93,280 |
| *Income scale* | | | | | | |
| Income - Central government sample | 4.83 | 5 | 2.43 | 1 | 10 | 65,595 |
| Income - General government sample | 5.03 | 5 | 2.53 | 1 | 10 | 110,780 |
| Income - Proportion subnational sample | 4.87 | 5 | 2.39 | 1 | 10 | 51,416 |
| *Political scale - 1 = left ;10 = right* | | | | | | |
| Political scale - Central government sample | 5.31 | 5 | 2.08 | 1 | 10 | 89,527 |
| Political scale - General government sample | 5.38 | 5 | 2.06 | 1 | 10 | 137,087 |
| Political scale - Proportion subnational sample | 5.27 | 5 | 2.03 | 1 | 10 | 74,624 |
| *Gender* | | | | | | |
| Female - Central government sample | 0.54 | 1 | 0.50 | 0 | 1 | 110,617 |
| Female - General government sample | 0.54 | 1 | 0.50 | 0 | 1 | 171,696 |
| Female - Proportion subnational sample | 0.54 | 1 | 0.50 | 0 | 1 | 93,240 |
| *EVS vs. WVS* | | | | | | |
| WVS - Central government sample | 0.51 | 1 | 0.50 | 0 | 1 | 110,659 |
| WVS - General government sample | 0.44 | 0 | 0.50 | 0 | 1 | 171,804 |
| WVS - Proportion subnational sample | 0.43 | 0 | 0.50 | 0 | 1 | 93,280 |
| *Age* | | | | | | |
| Age - Central government sample | 46.52 | 45 | 17.65 | 15 | 108 | 110,378 |
| Age - General government sample | 45.56 | 44 | 17.71 | 14 | 108 | 169,876 |
| Age – Proportion subnational sample | 46.94 | 46 | 17.76 | 15 | 108 | 93,020 |

*Note*: Education, and settlement size are also included as controls in our regressions, though (because they are categorical and cumbersome to summarize) they are not included in this table. Age is summarised here as a continuous variable but included in bins in the analysis (see Section 3.2 for details). The $N$ in the last column refers to the number of non-missing observations for that variable, but people with missing values for these personal controls are included in the analysis (with separate missing categories for each variable, again refer to Section 3.2 for more detail).

Table A.4: List of countries included in regressions

| Country | Central government regression | General government regression | Subnational proportion regression |
|---|---|---|---|
| Australia | 1 | 1 | 1 |
| Austria | 1 | 1 | 1 |
| Belgium | 1 | 1 | 1 |
| Canada | 1 | 1 | 1 |
| Denmark | 1 | 1 | 1 |
| Estonia | 1 | 1 | 1 |
| Finland | 1 | 1 | 1 |
| France | 1 | 1 | 1 |
| Germany | 1 | 1 | 1 |
| Great Britain | 1 | 1 | 1 |
| Greece | 1 | 1 | 1 |
| Hungary | 1 | 1 | 1 |
| Iceland | 1 | 1 | 1 |
| Italy | 1 | 1 | 1 |
| Luxembourg | 1 | 1 | 1 |
| Malta | 1 | 1 | 1 |
| Netherlands | 1 | 1 | 1 |
| Norway | 1 | 1 | 1 |
| Poland | 1 | 1 | 1 |
| Portugal | 1 | 1 | 1 |
| Singapore | 1 | 1 | 1 |
| Slovenia | 1 | 1 | 1 |
| Spain | 1 | 1 | 1 |
| Sweden | 1 | 1 | 1 |
| Switzerland | 1 | 1 | 1 |
| Cyprus (T) | 1 | 1 | 0 |
| Japan | 1 | 1 | 0 |
| United States | 1 | 1 | 0 |
| South Africa | 0 | 1 | 0 |
| Argentina | 1 | 0 | 0 |
| Chile | 1 | 0 | 0 |
| Czech Rep. | 1 | 0 | 0 |
| Ireland | 1 | 0 | 0 |
| Lithuania | 1 | 0 | 0 |
| Ukraine | 1 | 0 | 0 |

Table A.5: Baseline regressions

| Fiscal definition: | Central Government | Central Government | General Government | General Government |
|---|---|---|---|---|
| Non-distortionary taxes GG | | | -0.057*** | -0.100*** |
| | | | (0.012) | (0.014) |
| Distortionary taxes GG | | | -0.002 | -0.005 |
| | | | (0.007) | (0.007) |
| Productive exp. GG | | | 0.025*** | 0.046*** |
| | | | (0.007) | (0.008) |
| Unproductive exp.GG | | | 0.016** | 0.006 |
| | | | (0.008) | (0.01) |
| Other rev. GG | | | 0.039*** | 0.028** |
| | | | (0.01) | (0.011) |
| Other exp. GG | | | 0.156*** | 0.159*** |
| | | | (0.023) | (0.024) |
| Non-distortionary taxes CG | -0.045*** | -0.045*** | | |
| | (0.007) | (0.007) | | |
| Distortionary taxes CG | 0.005* | -0.002 | | |
| | (0.003) | (0.003) | | |
| Productive exp. CG | 0.043*** | 0.048*** | | |
| | (0.003) | (0.003) | | |
| Unproductive exp. CG | 0.001 | 0.015*** | | |
| | (0.004) | (0.004) | | |
| Other rev. CG | -0.005 | -0.010* | | |
| | (0.005) | (0.006) | | |
| Other exp. CG | 0.009 | 0.021** | | |
| | (0.008) | (0.008) | | |
| ln_gdppc | 1.041*** | 1.260*** | 0.758*** | 0.635*** |
| | (0.066) | (0.115) | (0.14) | (0.237) |
| ln_gdppc (t - 3) | | -0.405*** | | -0.026 |
| | | (0.091) | | (0.24) |
| inflation | | 0.002 | | -0.052*** |
| | | (0.001) | | (0.007) |
| investment | | 0.008** | | 0.036*** |
| | | (0.003) | | (0.006) |
| unemployment | | -0.007* | | 0.007 |
| | | (0.003) | | (0.006) |
| N | 171,804 | 169,900 | 110,659 | 110,659 |
| No. of countries | 34 | 34 | 29 | 29 |
| No. of country-time obs. | 129 | 127 | 79 | 79 |
| Personal controls | YES | YES | YES | YES |
| Survey wave fixed effects | YES | YES | YES | YES |
| Country fixed effects | YES | YES | YES | YES |
| R squared | 0.122 | 0.124 | 0.113 | 0.114 |

*Notes*: Robust standard errors in parentheses. Omitted fiscal category is the budget surplus, and hence the statistical significance reported by the stars refer to statistical difference from the surplus. Dependent variable is an individual's subjective wellbeing in all regressions. ln_gdppc is the natural log of GDP per capita. ln_gdppc (t - 3) is the natural log of GDP per capita 3 years ago. Personal controls are: age, education, gender, income (as a scale), political orientation, a dummy for survey type, and settlement size (see section 3.2 and Table A.3 for more details on these). Stars denote: * p<0.10, ** p<0.05, *** p<0.01

Table A.6: Subnational government regressions

| | (1) | (3) | (3) |
|---|---|---|---|
| Non-distortionary taxes GG | -0.166*** | -0.143*** | -0.140*** |
| | (0.021) | (0.022) | (0.024) |
| Distortionary taxes GG | 0.023** | 0.031*** | 0.038*** |
| | (0.010) | (0.010) | (0.012) |
| Productive exp. GG | 0.041*** | 0.021** | 0.018 |
| | (0.010) | (0.010) | (0.011) |
| Unproductive exp.GG | 0.005 | 0.047*** | 0.037** |
| | (0.013) | (0.015) | (0.017) |
| Other rev. GG | 0.030* | 0.090*** | 0.082*** |
| | (0.016) | (0.019) | (0.020) |
| Other exp. GG | 0.258** | 0.285** | 0.291** |
| | (0.114) | (0.116) | (0.124) |
| subnational proportion of NDT | -1.148*** | -6.275*** | -9.737*** |
| | (0.304) | (0.870) | (1.520) |
| (subnational proportion of NDT)**2 | | 8.768*** | 4.038 |
| | | (1.256) | (7.152) |
| (subnational proportion of NDT)**3 | | | 17.348* |
| | | | (9.214) |
| subnational proportion of DT | 0.535 | 0.695 | 4.413* |
| | (0.518) | (1.138) | (2.273) |
| (subnational proportion of DT)**2 | | -3.905** | -34.953*** |
| | | (1.785) | (8.923) |
| (subnational proportion of DT)**3 | | | 28.685*** |
| | | | (10.326) |
| subnational proportion of PE | 0.195 | -1.040** | -2.362*** |
| | (0.368) | (0.490) | (0.522) |
| (subnational proportion of PE)**2 | | 0.187 | 26.730*** |
| | | (1.418) | (3.504) |
| (subnational proportion of PE)**3 | | | -43.822*** |
| | | | (5.347) |
| subnational proportion of UE | -0.77 | -0.291 | 5.118*** |
| | (0.487) | (0.551) | (0.953) |
| (subnational proportion of UE)**2 | | -4.346** | -5.275*** |
| | | (1.766) | (2.041) |
| (subnational proportion of UE)**3 | | | -50.205*** |
| | | | (7.628) |
| N | 93,280 | 93,280 | 93,280 |
| No. of countries | 25 | 25 | 25 |
| No. of country-time obs. | 69 | 69 | 69 |
| Macro controls | YES | YES | YES |
| Personal controls | YES | YES | YES |
| Survey wave fixed effects | YES | YES | YES |
| Country fixed effects | YES | YES | YES |
| R squared | 0.103 | 0.104 | 0.105 |
| Adjusted R squared | 0.102 | 0.103 | 0.104 |
| Akaike information criterion | 382,521 | 382,479 | 382,400 |
| Bayesian information criterion | 383,342 | 383,338 | 383,297 |

See notes to Table A.5.

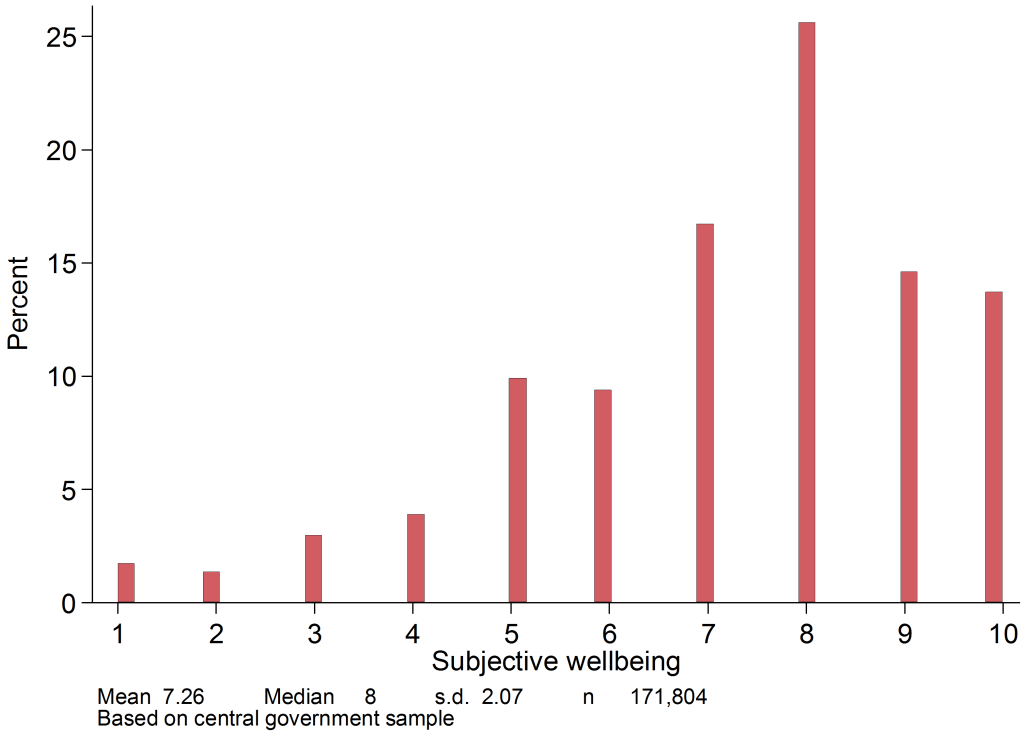


Figure A.2: Histogram of SWB

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# Regional Energy Efficiency Programs in Russia: The Factors of Success

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**Abstract.** In this paper, we study the reasons for extremely high difference in energy intensity of the Russian regions under different methodological approaches. We compare the most popular measures of state's energy efficiency policy in Russia with best world practices and investigate the factors of their effectiveness. We test the hypothesis that the level of development of regional innovation system determines how the regional economy reacts to the removal of market barriers to energy efficiency. Our findings reveal that in the face of rising electricity prices, regions with well-developed regional innovation systems induce technical and other kinds of innovation in the field of energy efficiency, while other regions are not able to reduce their energy intensity. The main practical implementation of the study is that market measures for improvement of energy efficiency do not work in the regions with underdeveloped innovation systems.

## 1 Introduction

During the last two decades, all industrially developed countries have shown a growth of attention to the matters of energy efficiency and energy saving. The convergence and diffusion of international energy efficiency policies (Busch, Jörgens 2012), mostly through the cooperation with IEA under the framework of the Joint Declaration signed in July 1994 (IEA 2002) and commercial and demonstration activities of international companies (Martinot 1998) has led to development of multiple laws and government programs in Russia during 1995-1998 for energy saving and increasing the energy efficiency (EE) of the national economy. However, the initial indicators for the process of realization of the state policy have been very low compared to other countries (IEA 2006). The Russian energy system was in a bad state due to the lack of investment and predatory exploitation of accumulated technological and material resources in previous years. Russian industry had inherited a very power-consuming structure from the USSR (Fromme 1996). The decrease of production during the nineties has also affected the energy efficiency of the economy negatively (Bashmakov, Myshak 2014). Due to these reasons, first versions of Russian EE policies had used such instruments as direct subsidies to the companies in the fuel and energy complex and energy-intensive industry branches, but did not affect other sectors of economy and households.

Since the year 2000, Russia's energy efficiency has achieved much more promotion compared to that of the previous decades (Zhang 2011). However, the main period of implementation of various EE programs and projects has matched with the period of recovering economic growth in Russia after the decrease of industrial production by

some 40% in 1991–1999. Therefore, evaluating the success of implementation of the governmental efforts for increasing energy efficiency and the factors of this success (or failure) is non-trivial.

An important fact is that in the middle of past decade the focus of Russian EE policy has moved from federal to regional level due to the fundamental differences in nature, climate conditions, and power supply of the fuel and energy balance of macro-regions of the country. Russian regions have developed their own EE policies that together with above-mentioned fundamental factors have led to a significant difference in energy intensity of regional GDPs. A vast literature basis in Russian addressed the issue of the quality of regional energy management (Volkova et al. 2012). However, a closer look on the problem reveals that neither heterogeneous climate and infrastructural conditions, nor the quality of regional management can be a comprehensive explanation of extremely high differences in energy intensity of regional economic systems (Ratner 2014).

The goal of this paper is the investigation of factors that affect the success of implementation of various state EE programs and measures. Under the framework of extensive energy-efficiency gap methodology (Backlund et al. 2012) we study different barriers for energy efficiency. The main hypothesis of the study is that the reduction of cost barriers for energy efficiency induces variegated rates of energy technology innovation in different regions mostly depending on the effectiveness of the innovation system in the relevant regions. This idea was initially formulated to explain international variation in the form of reaction to oil shocks and energy price increases (Newell 2010, Popp 2002) and then empirically tested for national innovation systems of 23 industrialized countries that joined the OECD before the year 1989 (Cheon, Johannes 2012). In our study, we test this theoretical argument on the regional level using the Russian Federal State Statistic Agency database.

The structure of the paper is as follows: Section 2 presents a brief analysis of evolution of goals, tasks, and instruments of Russian EE policies on the federal level. Sections 3 and 4 analyze various approaches and tools for realization of regional EE programs. In Section 5, using different theoretical approaches, we investigate possible causes for success and failure of regional EE programs. In Section 6, we test the main hypothesis of our study using econometric modelling. The concluding section (Section 7) of this work discusses different possibilities of practical application for our findings.

## 2 Russian energy efficiency policy: matching the world trend

Presently Russia is the third-largest contributor to total greenhouse gases emissions (GHG) in the world, after China and the USA. Recently launched policies of energy efficiency in the Russian Federation resulted in impressive GDP energy intensity and correspondent GHG- intensity decline over the last 15 years. Nonetheless, there is still a significant energy-efficiency gap, which refers to a number of socio-economic phenomena, well-investigated in the world literature, but not sufficiently studied in the Russian scientific community. Introduced in 1994 by American economists A. Jaffe and R. Stavins (Jaffe, Stavins 1994), this term refers to a situation in the socio-technical system, where existing technical and technological possibilities of energy efficiency (including the use of alternative sources of energy) go under-utilized despite their potential economic viability. Explanations for this situation, various in nature, commonly receive categorization as social and institutional barriers (Brown 2001, Eyre 1997, Almeida 1998, Sorrell et al. 2000, IEA 2007).

Despite the lack of theoretical works by Russian scientists dedicated to the study of energy efficiency gap there is a lot of empirical evidence of this phenomenon in the scientific literature (Fromme 1996, Korppoo 2005, Ratner, Iosifova 2014).

The outcome of EE policy efforts can be easily visible when measured by decreasing energy intensity of GDP and/or absolute decrease in the use of fuel. However, the real factors of energy intensity reduction may be latent, so the implementation of the same measures and policy instruments can provide effects in energy saving of different sizes in a variety of socio-technical systems.

It should be noted that most of the Russian state EE policies is an adaptation or a

generalization of global best practices in this field, and their evolution over the period of 1995-2013 is consistent with global trends described by Tanaka (2011). Recent Russian EE policies are presented in a number of official documents of different types – state strategies, state (federal) and regional laws and state (federal) programs on energy efficiency. The main energy policy targets of Russia are presented in its Energy Strategies (ES). All three ES (of 1995, 2003 and 2009) noted the importance of EE, but in a different proportion. The basic principles and measures of energy conservation and energy efficiency policy are presented in federal laws (FL) on energy efficiency (1995, 2009). However, the provisions of these issues have been really supported only by federal programs on energy efficiency (1998, 2001, 2013). Thus, the transition of the policies' primary purposes can be seen in ES and FL, but the real shifting in focus can be evaluated only through joint-comparative analysis of all these official papers.

A detailed analysis of the evolution of Russian EE policy shows that in the period 1995-2013 a significant shift in focus from issues of energy conservation (measured in absolute terms of energy saved) on energy efficiency (measured as the amount of energy used per unit of production) has happened in Russia as well as in most countries of the IEA (Ratner 2014). In addition, an increased attention to the problems of climate change and sustainable development can be noticed. This fact can be easily interpreted as a manifestation of the diffusion of management innovations in the field of environmental problems and energy efficiency, which has been widely investigated in numerous theoretical and empirical studies (Holzinger et al. 2008, Busch, Jörgens 2012, Schaffer, Bernauer 2014).

Another global trend – the transformation of ratio of the two main approaches in EE policies: (1) from the sectoral measures to instruments applicable in whole industries and even across the national economy and (2) maximization of social and environmental impacts of introduced incentives (Sandén, Azar 2005) – is not so obvious. Indeed, analyzing the content of federal laws and programs for evidence of replacing such sectoral measures as direct regulation and direct subsidies with more universal tools as energy taxes, taxes on greenhouse gas emissions, and organization of emissions trading, it is difficult to notice any significant change in the prevailing approach of direct subsidies.

However, if one shifts the focus of research from the federal to the regional level, the desired trend becomes observable. The legitimacy of such a shift of the focus of research is confirmed with some theoretical arguments thoroughly discussed in the next section, as well as with an analysis of the government's report on the implementation of the Federal Program "Energy Efficient Economy" for the period 2002-2005 and up to 2010 (approved by the Russian Government in November of 2011). In 2005, the program was considered 99% fulfilled, however, despite the successful implementation its prolongation was considered by experts as inappropriate. The main reason was the presence of significant institutional barriers to the development of market mechanisms to encourage energy efficiency.

In 2006-2013 the major efforts to promote energy conservation and efficiency had moved into a sphere of responsibilities of the regional authorities. The new version of the Federal program "Energy saving and energy efficiency for the period up to 2020" (approved in April of 2013) did not change this situation. The basic approach to the implementation of EE policies in the program became the co-financing on a competitive basis of regional programs on energy conservation and efficiency.

## 3 The role of regional governments in realization of EE policy

The shutdown of energy saving programs in 2006 has clearly shown that sectoral measures and, in particular, direct subsidies of projects in the fuel energy complex as a main energy consumer are no longer useful (Ratner 2014). The most important problems of this branch, including critical deprecation of main funds and inefficient use of fuel in electricity generation, have been solved (see Figure 1).

The primary idea of the newer and wider approach to developing EE policies has been dictated by the strong spatial heterogeneity of the Russian economic and energetic systems. These conditions have caused regional governments to be viewed as potential mediators

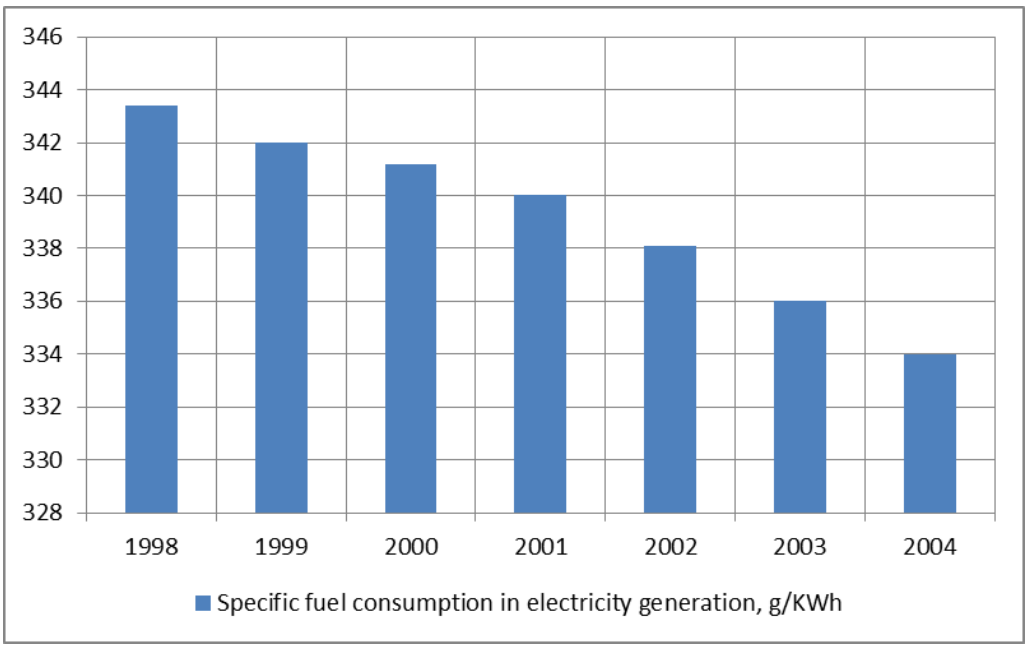


Figure 1: Specific fuel consumption in electricity generation in Russia

between the federal government and individual companies and organizations that may evaluate the real social and economic conditions more adequately due to collecting, compiling, generalizing and distributing data necessary to form EE policies.

However, apart from the traditional argument of strong regional differentiation, the switch of focus for energy efficiency policies to the regional level can be further supported by a less popular, yet no less important argument: advantages of federalism for generating and diffusing managerial innovation. The positive influence of the federal government on the speed and quality of managerial decisions has been reasoned for in the works of Scruggs (2003), Levy (2007) and several other scientists, originally applied to ecological policies. That is explained by the fact that independence of regions in creating laws allows more space for experimentation and diffusion of best practices. The processes of diffusion for managerial innovations are stimulated by competition between regions for resources and induce learning effects. An empirical confirmation for these theories has been given very recently by (Schaffer, Bernauer 2014), who have managed to create econometric models for European statistics that confirm positive correlations between the federal structure of a state and the level of development of its ecology policy.

## 4 Regional programs on energy efficiency

First regional laws on energy efficiency were passed in 1996-1998 right after the first Federal Law of Russian Federation "On energy efficiency" No. 28-FZ. They did not provide any effective instruments to promote energy saving and did not set any specific goals. Some regions approved only limited number of legal acts, dealing with particular questions of energy efficiency such as street-lighting (Novgorodsky Region), limited energy consumption in regional government organizations (Jewish Autonomous Region, Magadan Region, Tambov Region, etc.) or energy audit in public sector companies (Republic of Bashkortostan, Sverdlovsk Region, etc.). First regional programs on energy efficiency (1998-2003) were also very restricted in policy instruments and therefore not very effective.

Regional programs in 2004-2008 were more specific in the development of new methods of incitement and motivation and pointed to the elaboration of new market-based instruments as a prior goal. Analyzing regional legislative acts adopted in 1997-2008, the following most popular tools to stimulate energy conservation and efficiency can be found: (1) funding for installation of meters from the budgets of all levels; (2) funding for regional EE programs from regional budgets; (3) funding for energy audit of the regional

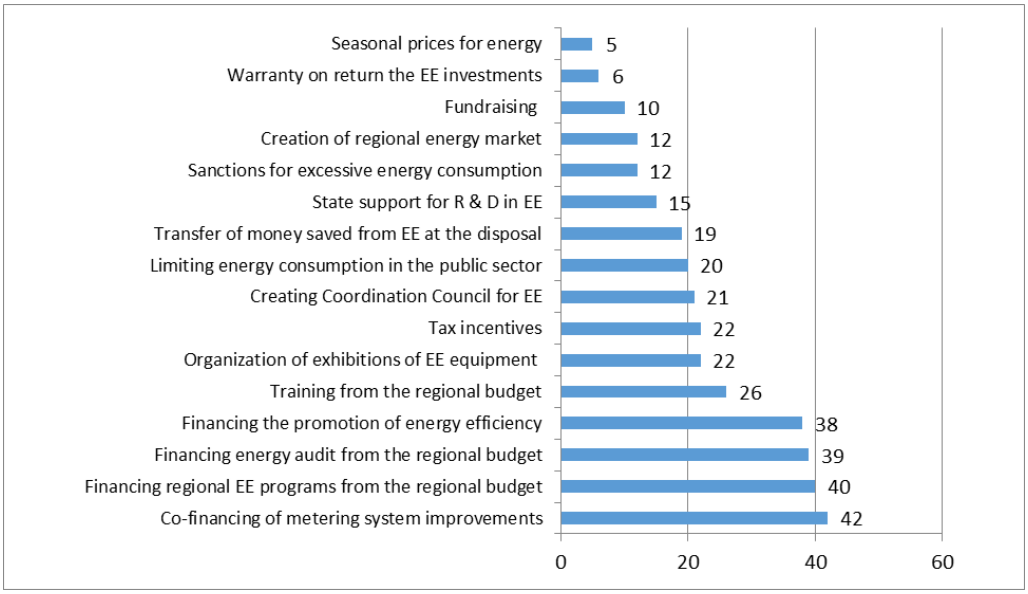


Figure 2: Instruments of implementation of regional policies on energy-efficiency in 1997-2008

budget; (4) the financing of information campaigns on EE from regional budgets; (5) funding for the training of specialists in the field of energy saving from regional budgets (see Figure 2).

Using the classification proposed by Tanaka (2011), all the selected instruments of regional EE programs can be divided into three main groups: administrative, economic, and supportive. It is easy to notice that economic (co-financing, subsidies, tax incentives) and supportive (training, information) tools dominate among other instruments of regional programs. This is consistent with modern global trends of evolution of EE policies in industrialized countries.

In most regions, EE measures have brought about the expected effect (Ratner 2014). In addition, the implementation of regional EE programs generated a new tendency of smoothing existing extreme differences in energy intensity of the regions (see Table 1).

Investigation of regional statistics data does not help to mark the most important factors of energy intensity decline[2]. Thus, comparing the data, presented on Figures 3 and 4, one can see that the rate of energy intensity decline differs in the group of regions with similar climate conditions (Krasnoyarsk Region, Irkutskaya Oblast, Altay Republic and Tomskaya Oblast are all located in Siberia) as well as in the groups of regions with the same structure of economy (for example, Krasnoyarsk Region and Kaluzhskaya Oblast with leading manufacturing sector or Krasnodar Region, Penzenskaya and Tambovskaya Oblast's with significant share of agriculture and transport in regional GDP).

According to recent statistics, the energy intensity of the majority of Russian regions (67.5%) is in the range from 200 to 400 kg of fuel equivalent per 10 thousand RUB of gross regional product (GRP) (see Figure 5). Only two regions – Moscow City and Sakhalin region have energy intensity less than 100 kg of fuel equivalent per 10 thousand RUB. In twelve regions – the Republic of North Ossetia-Alania, Dagestan Republic, Sakha Republic, St. Petersburg City, Kaliningrad, Magadan, Tomsk, Kaluga, Khabarovsk, Kamchatka, Jewish Autonomous and Chukotka Autonomous regions – energy intensity is less than 200 kg f.eq./10 thousand RUB.

Thus, the group of least energy intensive regions (less than 300 kg of fuel equivalent per 10 thousand RUB) includes regions that vary considerably according to the sectoral structure of the economy, and on climatic conditions. For example, it includes such

[2]In some Russian statistical digests, energy intensity is presented as a ratio of kg of fuel equivalent and GDP and expresses full energy intensity, but in most statistics, one can find data only on electric intensity (a ratio of kWh and GDP). Since all the regions of Russia are fully electrified, we assume that the electric intensity of the region economy is proportional to its total energy intensity.

Table 1: Descriptive statistics of energy intensity of Russian regional economy systems. Calculated according to the statistical digest "Industry of Russia-2012"

| | Energy intensity of regional GDP, kg of fuel equivalent[1] / 10 thousand rubles | |
|---|---|---|
| | **2009** | **2010** |
| Mean | 342.23 | 313.61 |
| Standard error | 18.53 | 16.91 |
| Median | 307.54 | 280.88 |
| Standard deviation | 165.76 | 151.21 |
| Sampling variance | 27475.74 | 22865.39 |
| Kurtosis | 3.37 | 3.34 |
| Asymmetry | 1.60 | 1.61 |
| Range | 905.68 | 852.90 |
| Minimum | 48.81 | 45.00 |
| Maximum | 954.49 | 897.90 |
| Valid Number of Observations | 80 | 80 |

[1] According to Russian statistics 1 kg of fuel equivalent equals 29.31 MJ

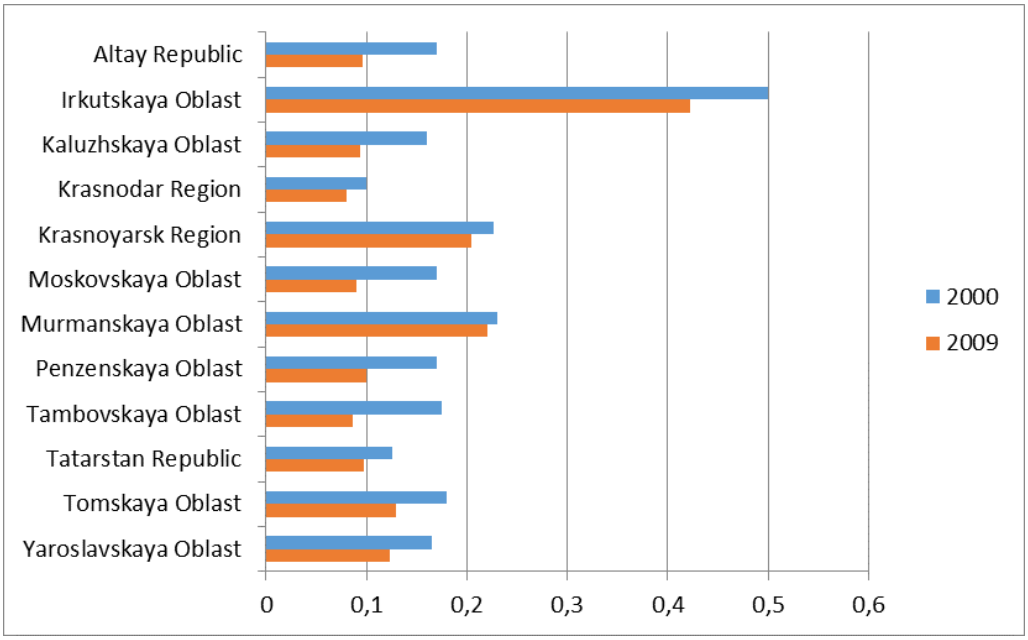


Figure 3: Changing in electrical energy intensity of some regional GDP during 2000-2009 (mill kWh/thous. rub) Source: Author own study

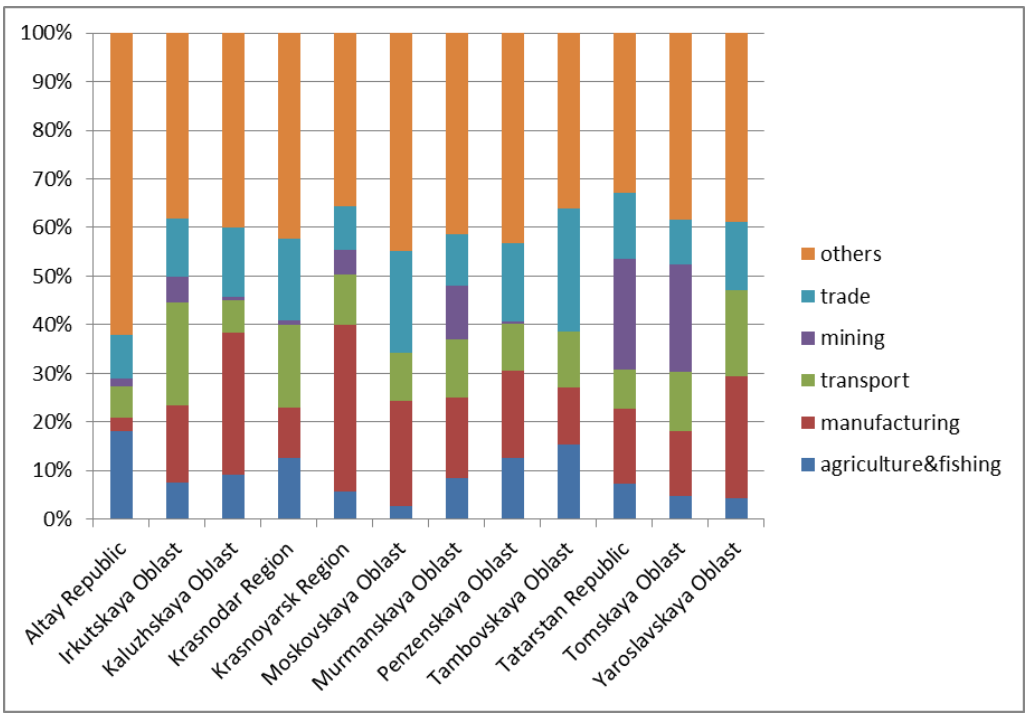


Figure 4: The share of main industries in regional GDP for chosen regions (2009)
Source: Author own study

oil and gas regions as the Republic of Sakha (Yakutia) and Sakhalin Oblast, as well as industrialized Kaluga region and two capitals – Moscow and St. Petersburg. This group consists of both southern republics, such as Dagestan and North Ossetia-Alania and northern regions, such as Magadan, Kamchatka and Chukotka.

At the same time, 12 Russian regions – Vladimir, Tula, Irkutsk, Orenburg, Kemerovo, Chelyabinsk, Lipetsk and Vologda regions, the Republics of Chechnya, Karachay-Cherkessk, Buryatia and Khakassia – have GRP energy intensity from 400 to almost 900 kg f.eq./10 th.RUB (see Figure 6).

As in the previous case, the group includes regions with different sectoral structure of the economy (for example, agricultural Chechen Republic and the heavily industrialized Lipetsk region) and regions that belong to completely different climatic zones (e.g., southern Karachai-Cherkessk Republic and the northern Republic of Khakassia).

To evaluate the impact of the branch structure of regional economy on its energy consumption, a series of single-factor ANOVA tests have been performed. The statistical data on the volume of shipped goods of own production, works and services carried out in-house by economic activity (in actual prices, mln. rub.) from the digest "Regions of Russia. Socio-economic indicators – 2010" was used. According to (Ministry of Energy, 2009), industrial consumption is a dominant in the structure of energy consumption in the Russian economy. 43% of consumption is spent on mining and manufacturing, and if the needs of power plants themselves are included, this accounts for over 50%. The ANOVA analysis, therefore, has been used to evaluate the effect of "volume of regional production by mining", "volume of regional production by manufacturing" and "volume of production and distribution of electricity, gas and water in region" on the GRP energy intensity.

In the first case, regions have been divided into four groups, depending on the amount of mining production in 2009. The most productive regions (100,000 million rubles and above) were the Republic of Sakha, Republic of Komi, Republic of Tatarstan, Arkhangelskaya, Orenburgskaya, Kemerovskaya, Sakhalinskaya and Tyumenskaya oblasts, as well as the Moscow city, which was excluded due to statistical peculiarities. The resulting indicator taken was the energy intensity of the GRP in 2009.

As can be seen from data provided in Table 2, the $p$-level of the $F$-test is significantly

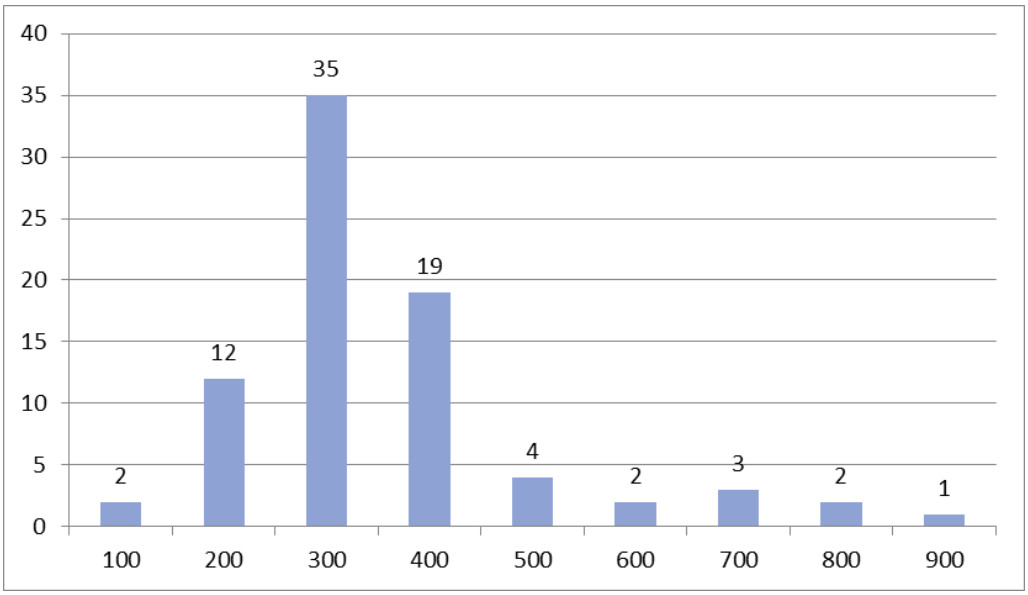


Figure 5: Number of regions with energy intensity of given range (kg of fuel equivalent per 10 thousand rubles in 2010)

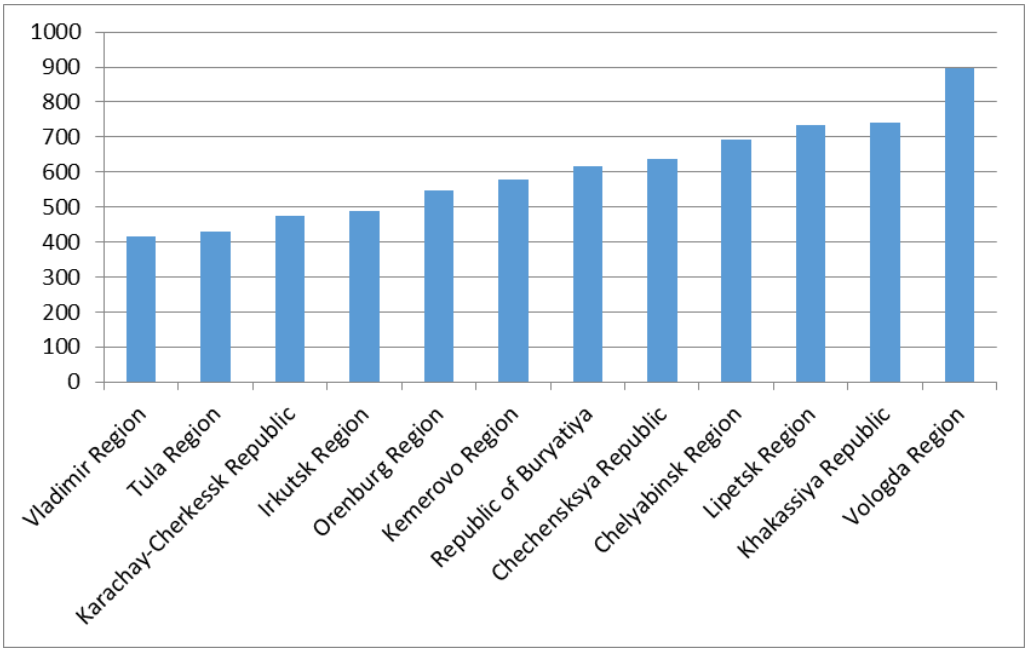


Figure 6: Most energy intensive Russian regions (kg of fuel equivalent per 10 thousand rubles in 2010)

Table 2: The results of ANOVA-tests

| Independent variable | Number of groups | $F$-calculated | $F$-critical | $p$-level |
|---|---|---|---|---|
| Volume of regional production by mining in 2009 | 4 | 0.673 | 2.726 | 0.571 |
| Volume of regional production by manufacturing in 2009 | 4 | 1.623 | 2.725 | 0.190 |
| Volume of production and distribution of electricity, gas and water in region in 2009 | 4 | 1.020 | 2.726 | 0.388 |

Table 3: GRP energy intensity for regions with a high share of metallurgic production in the volume of shipped production in the economic activity of manufacturing

| Regions | GRP energy intensity | The level of the volume of production by economic activity "Manufacturing" | Share of metallurgic production, % |
|---|---|---|---|
| Lipetsk Region | 866.92 | Middle | 65.6 |
| Volgograd Region | 954.49 | Middle | 65.8 |
| Krasnoyarsk region | 367.39 | Middle | 66.1 |
| Murmansk region | 353.56 | Low | 66.9 |
| Republic of Khakassiya | 859.38 | Low | 72.2 |

larger than the required value of 0.05, therefore, the factor of regional division into groups on mining activity has no significant effect on the energy intensity of the GRP.

In the second case, we checked the impact of manufacturing volumes on the energy intensity of the GRP. The regions were similarly divided into four groups by production volume: insignificant (below 20,000 million rubles), low (20,000-100,000 million), middle (100,000-500,000 million), and high (over 500,000 million). The high-volume group for this economic activity includes the republic of Tatarstan, Chelyabinsk, Nizhegorodskiy, Sverdlovsk, Tyumen regions, and the cities of Saint Petersburg and Moscow.

The ANOVA results show that the $F$-statistics (1.623) does not exceed the critical value of 2.725 on the required significance level ($p = 0.05$). The null hypothesis on the lack of impact from manufacturing volumes on the energy intensity of the GRP is therefore accepted.

The research of impact of the production volumes for the economic activity "production and distribution of electricity, gas and water" on the energy intensity of the GRP was performed in a third ANOVA-test. Regions were also split into groups of four, with insignificant (below 10,000 million rubles), low (10,000-20,000 million), middle (20,000-50,000 million) and high (above 50,000 million) volumes of production. The high production volume group for this indicator includes the republics of Tatarstan and Bashkortostan, Novosibirsk, Rostov, Orenburg, Chelyabinsk, Irkutsk, Leningrad, Saratov, Nizhegorodskiy, Samara, Kemerovsk, Sverdlovsk, Tyumen Moscow, Krasnodar, Perm and Krasnoyarsk regions and the cities of Saint Petersburg and Moscow.

The evaluated $F$-statistics value equals 1.02, and the critical value on the required statistical significance level (0.05) is 2.726. Therefore, the null hypothesis on the absence of impact from the economical activity of production and distribution of electricity, gas and water on the energy intensity of regional economy is accepted.

The latter results appear questionable and seem to contradict common sense in that the structure of the economy normally defines its energy intensity. However, they can be explained as follows: 1) the GRP energy intensity indicator, which is measured in a unit of standard fuel per unit of production, includes not only the energy consumption of the main production processes (which are typically electrified), but also the supporting ones (logistics, infrastructure support, etc.); and 2) the mean statistical indicators for regions and regional groups present only an overall outlook on the issue, "blurring" the specifics of production processes and accounting for factors that are not included in direct statistical measurements, such as the level of technology, quality of management and infrastructure, staff experience, etc.

A more detailed comparative analysis of the GRP energy intensity for regions with a high share of metallurgic production (which is assumed the most energy intensive) in the volume of shipped production in the economic activity of manufacturing is presented in Table 3.

It is apparent that the GRP energy intensity is significantly different for the regions of Lipetsk, Volgograd and Krasnoyarsk, which are part of the same region group with a medium production volume in manufacturing and an insignificant difference in metallurgy

Table 4: Results of single factor ANOVA test

| The level of energy intensity (EE) | Number of regions | Average | Variance | $F$-statistics ($p$-value) |
|---|---|---|---|---|
| Minimal EE | 14 | 3.347 | 1.488 | 7.691 |
| Maximal EE | 11 | 2.272 | 0.608 | (0.001) |
| Average EE | 49 | 2.596 | 0.278 | |

in the structure of the shipped goods volume. A similar observation can be made comparing the energy intensity of the Murmansk region and the Republic of Khakassiya, which belong to the same region group with a low manufacturing volume and insignificant differences in metallurgy in the structure of the shipped goods volume.

Either way, these results indicate that the energy intensity of a regional economy depends not only on its structure, but also on other factors, which are not paid enough attention in the Russian literature.

## 5 Barriers to energy-efficiency

In the framework of the energy efficiency gap methodology, factors that possibly affect the energy intensity of the Russian regional economies include cost barriers and non-financial barriers. Let us review this question with greater scrutiny.

Given the fact that the tariffs for electricity and heat in the regions differ significantly, one possible explanation for these differences may be the presence of so-called "market barriers", which can be divided into three main groups determined by instances (IPCC 2001, IEA 2007):

1. when energy prices are not an important factor in economic development;
2. when energy prices are low relative to other goods and services;
3. when the situation in capital markets impedes investment in energy-efficient technologies.

The existence of two first groups of market barriers can be considered as legitimate explanation if the regions with higher energy prices are less energy intensive. In case of high energy prices, a lot of EE-measures and technologies can become cost-effective and, therefore, more wide-spread causing regional economy to be less energy intensive. Such a pattern is actually observed in practice: our calculations carried out according to the statistic data[3] showed that the average electricity flat-rate tariff for the least energy-intensive regions is substantially higher than the average tariff in the group of the most energy-intensive regions. This result is also proved with a single factor ANOVA test for all groups of regions (least, average and most energy intensive) on the $p$-level 0.001 (see Table 4).

However, a strong variation in the tariffs in the group of regions with the least energy-intensive economies raises a question: can we consider market barriers (at least the first two of their group) an exhaustive explanation for the phenomenon that we study? The theory of energy efficiency gap clearly tells us that there are many economic, organizational, and behavioral obstacles that can stop cost-effective measures and technologies from wide practical implementation.

The most important non-market barriers to energy-efficiency in this time period have been illustrated and examined in multiple academic articles (Martinot 1998, Korppoo 2005, World Bank Group 2008, Ratner 2014). They highlight the lack of individuals motivated by environmental values; lack of expertise and competences to identify the inefficiencies; incomplete markets for energy efficiency; perception of being already efficient; and the lack of information about energy efficiency and renewable energy costs, benefits,

[3] Russian statistic database on energy tariffs in different regions http://www.energo-konsultant.ru

geographic resources and opportunities. All these obstacles can be treated as institutional and behavioral barriers (Golove, Eto 1996, Sorrell et al. 2000, Vine et al. 2003). The manifestations of such barriers are difficult to measure, that's why all of the above mentioned papers present the results of case studies or expert analysis and do not provide a quantitative information that helps to find a functional dependence of energy efficiency on institutional and behavioral factors.

Therefore, despite the popularity of the concept of extended energy efficiency gap proposed in Western literature as an explanation of many phenomena (including differences in energy intensity of production), we suggest that the main explanation for extremely high variances in the energy intensity of the Russian regions is the hypothesized difference in development of regional innovation systems.

It is known from the theory of innovation that external shocks (such as the rise in energy prices) initiate different responses in energy efficiency in the countries with advanced national innovation system (NIS) and in countries with underdeveloped NIS (Cheon, Johannes 2012, Popp 2002). The reaction of the countries that have developed NIS and a strong technological base is usually the growth of innovative activity in the field of energy efficiency and renewable energy, resulting in an increase in the number of patents in relevant areas of science and technology. The reaction of countries with underdeveloped NIS is to increase public funding for research and development in respective fields of knowledge, but the focus is on the development of already known technology in the country (Bergek et al. 2008, Jacobsson, Bergek 2004, Lipp 2007). For example, if a country owns a nuclear power technology, but does not develop the technologies of solar or wind energy, the funding most likely will be spent on research and development in the field of nuclear energy at the expense of all other areas (Unruh 2000, Newell 2010). This hypothesis has not been studied in either Russian or international literature on the regional level so far.

In the next section, we investigate the correctness of these theoretical and empirical findings for the level of regional innovation systems (RIS).

## 6 The reaction of regional innovation systems to elimination of market barriers to energy efficiency

The term "regional innovation system" (RIS) henceforth refers to the meso-level of the national innovation system (NIS): a combination of regional state, private, and social organizations and mechanisms of their interaction, in the framework of which activity on creating and sharing new knowledge and technology takes place (Golitchenko 2006).

The hypothesis of our study is that regions with more developed regional innovation systems are capable of responding to external shocks associated with a sharp increase in electricity tariffs by the introduction of various EE-innovations that eventually affect the energy intensity of the GRP.

Following the traditional approach (Golitchenko 2006), we use the indicators of the RIS development level that reflect the state of the entrepreneurial environment and knowledge generation environment and mechanisms of knowledge transfer. Considering the specifics of the research task and limited abilities of the Russian regional statistics, the set of indicators of RIS development is decreased to four primary ones: the share of innovative production in overall shipped goods, performed works and services (susceptibility of the entrepreneurial environment to innovations); the volume of domestic spending on research and development financing; the number of issued patents (effectiveness of R&D); and the number of developed leading production technologies (conformity of R&D to the needs of technological development, as an indirect indicator of the knowledge transfer mechanism efficiency).

The increase of domestic electricity tariffs of 2007-2008 and 2010-2011, which are directly connected to the reforms of the electricity sector aimed at the liberalization of the electricity market may be viewed as an external shock to the economy of Russian regions (Ratner, Iosifov 2013). With the stable significant price variation between the different regions, the average flat–rate tariff for electricity in Russia has increased by 25% over one year (see Figure 7).

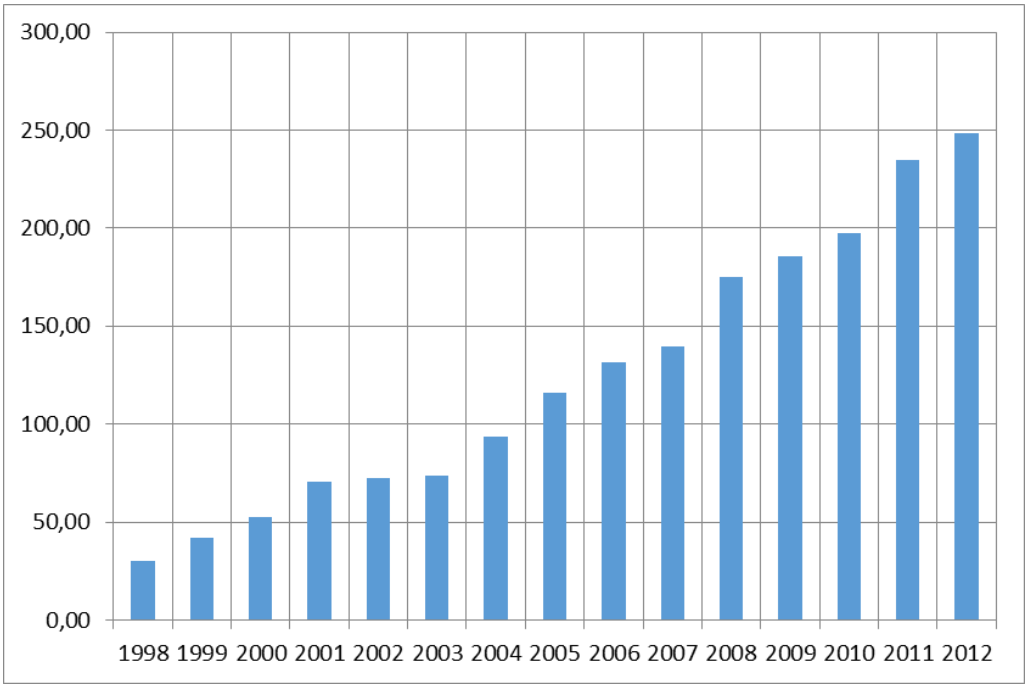


Figure 7: Electricity flat-rate average tariffs (RUB for 100 KWh) in Russia in 1998-2012

Table 5: Results of research for impact of RIS development level indicators (average for 2008-2009) on intensity of the innovative process in increasing energy efficiency

| Independent variable<br>Independent variable | Number of groups | $F$-calculated | $F$-critical | $p$-level |
|---|---|---|---|---|
| Internal R&D spending | 4 | 5.329 | 2.725 | 0.002 |
| Amount of developed leading production technologies | 2 | 4.571 | 3.963 | 0.036 |
| Amount of patents issued | 4 | 4.530 | 2.725 | 0.006 |
| Share of innovative produce in overall volume of goods, products and services | 4 | 6.198 | 2.725 | 0.001 |

It is important to note that official statistics contain little information on what share of R&D performed by organizations is meant to increase energy efficiency. Only since 2010, the statistical digest "Regions of Russia. Socio-economic indicators" contains data on share of organizations (out of all companies that have undergone research in the region) that perform ecologic innovations. This is defined as "improvements realized as part of technology, marketing or organizational innovation for the purpose of increasing ecological safety of the production process and use of the innovative product". Innovations meant to decrease energy consumption for producing a unit of goods or services are considered a subtype of ecologic innovations.

The share of companies working on EE-innovations for the year of 2010 (the earliest regional statistical data available) was used as the dependent variable in ANOVA analysis, the purpose of which was to find out whether the level of development of the regional innovation system affects the intensity of the innovative process in increasing energy efficiency. The results of ANOVA are presented in Table 5, the average values of dependent variable are presented in Figures 8 to 11.

The regions were divided into groups depending on the value of the independent factor, such that considerable differences in indicator values are accounted for and the amount of regions in each group is approximately equal to that in others. Frequency tables were built for each indicator beforehand.

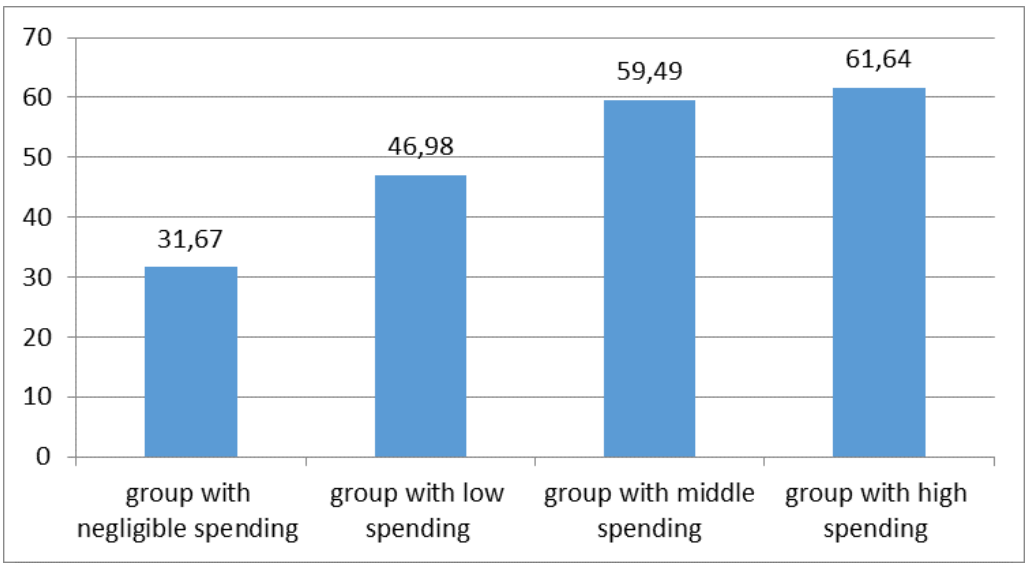


Figure 8: Average values of share of companies implementing energy efficiency innovations by groups of regions with different volumes of domestic R&D financing

Table 6: Statistical characteristics of regression model

| | |
|---|---|
| Regression coefficient $a$ | 0.224 |
| Standard error of regression coefficient | 0.031 |
| $t$-statistics of regression coefficient | 7.291 |
| $p$-level of t-statistics | 0.001 |
| $F$-statistics | 53.16 |
| $p$-level of $F$-statistics | 0.002 |
| Degrees of Freedom | 79 |
| Determination $R^2$ | 0.402 |
| Correlation | 0.634 |

It is apparent that not all indicators of RIS development affect the intensity of the innovative process in increasing energy efficiency, which is measured as the share of companies working on innovations to reduce energy consumption per unit of produce.

Let us review the question of how the intensity of the innovative process in energy efficiency improvement (measured as the share of organizations that perform innovations for reducing energy consumption per unit of produce) affects the energy intensity of the GRP. Using data on share of companies that perform energy efficiency innovations in 2010 (statistical digest "Regions of Russia. Socio-economic indicators – 2011") and calculating the rate of decrease for GRP energy intensity based on data of years 2010-2011 (statistical digest "Russian industry – 2014"), we have built a model of linear regression that fits for all regions and shows the dependence of decreasing rate of GRP energy intensity on the share of organizations that perform energy efficiency innovations (see Table 6).

## 7 Conclusions

The following hypotheses were confirmed by this research:

1. The slow rate of decreasing energy intensity of the economy in Russia during the period of realizing state policies in energy saving and increasing energy efficiency (1998-current time) is not a result of inadequate choices or bad knowledge of tools for realizing this policy. The evolution of goals, problems, and tools of realizing current Russian energy efficiency policy follows the worldwide trends quite well. The findings have important practical implications for the future process of EE-policy elaboration and implementation. According to our results, in the case of

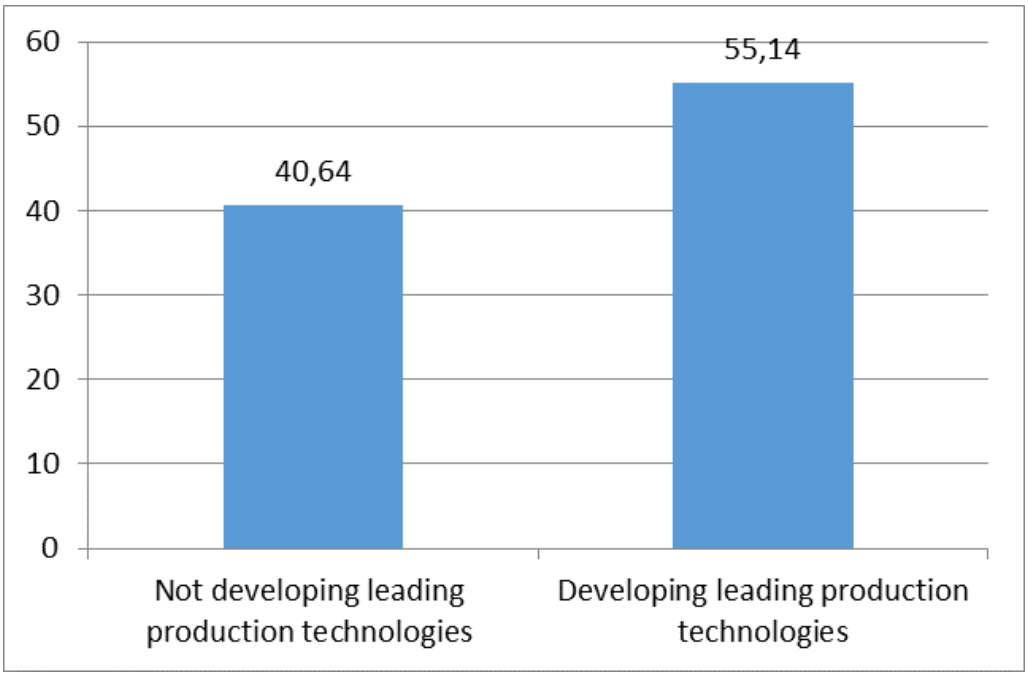


Figure 9: Average values of share of companies implementing energy-efficiency innovations by group of regions that performed (or didn't perform) development of leading production technologies

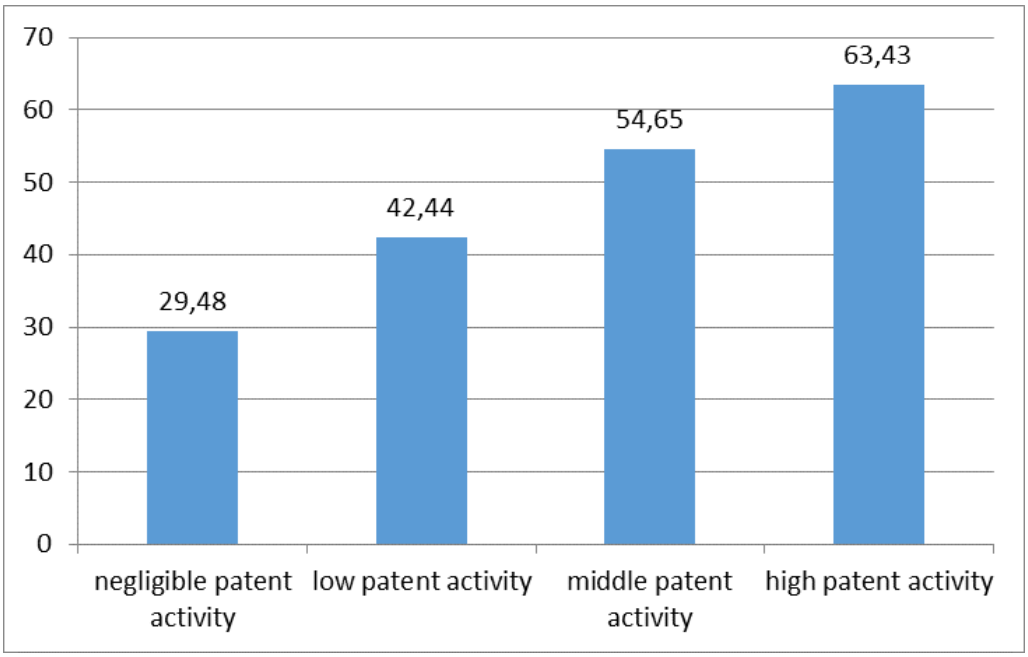


Figure 10: Average values of share of companies implementing EE-innovations by group of regions with differing patent activity

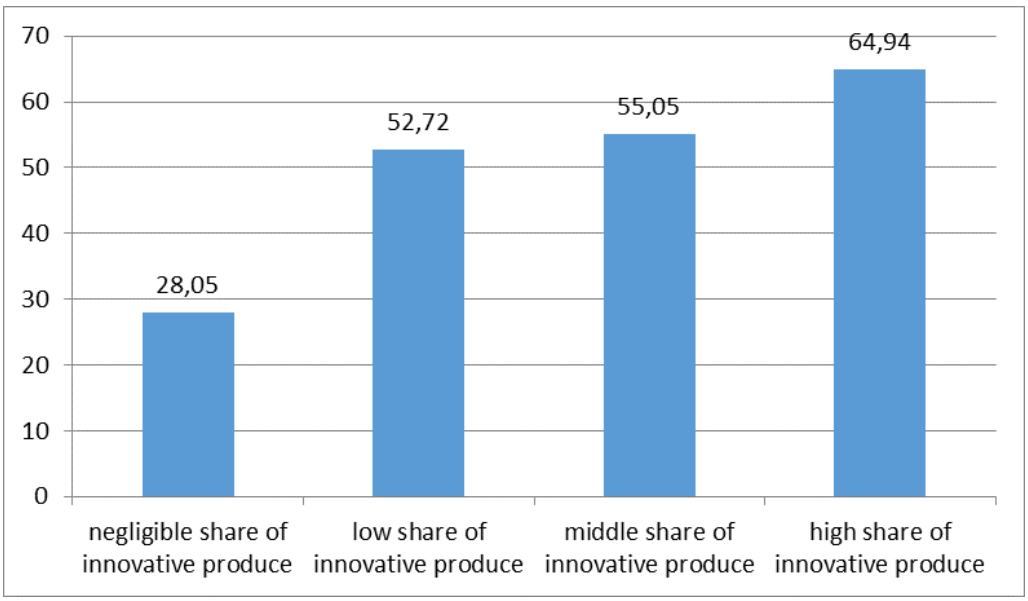


Figure 11: Average values of share of companies implementing EE-innovations by group of regions with differing share of innovative produce in overall production

a lack of effectiveness of regional EE- programs, the experimentation with new management tools is not necessary and helpful. The specific kinds of managerial tools are unimportant as long as they meet the current practice, but continuity and duration of their use is. Regions in which the implementation of EE-programs has not brought tangible results so far, need government support for the development of regional innovation systems. Regions which have reached some success in reducing the energy intensity of GRP are able to respond adequately to reduction of market barriers for energy efficiency and do not need government subsidies to regional EE-programs anymore;

2. As in many other technologically developed countries, there are certain barriers to increasing energy efficiency in Russia, including market and institutional barriers;

3. Extreme differences in energy intensity of regions of Russia are explained not only by structural, natural, and climatic peculiarities, but also by the level of development of regional innovation systems. Regions with better-developed innovative systems can react faster and more intensely to removal of market barriers for energy efficiency by decreasing the energy intensity of gross regional product (GRP).

These results have an important meaning for further formation and realization of state policies on energy efficiency. They show that in case of insufficient efficiency of regional EE-programs, experimenting with new management tools is unnecessary and unfounded. The management tools are less important than the consistency and length of their use, as long as the tools conform to the modern practice.

Regions, in which realizing EE-programs has not borne any notable fruit yet, require state support for developing regional innovative systems. These supportive measures do not necessarily need to be of economical character. Regions that have been, on a certain level, successful in decreasing GRP energy intensity, are capable of adequately reacting to removal of market barriers for energy efficiency, and no longer require state subsidies for regional energy efficiency and energy saving programs.

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# Population Structures in Russia: Optimality and Dependence on Parameters of Global Evolution*

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**Abstract.** The paper is devoted to analytical investigation of the division of geographical space into urban and rural areas. A city has an attractive potential based on scale economies. For moderate scale effects optimal population of a city depends negatively on transport costs that are positively linked to energy price index. In the last 10 years we have observed substantial volatility of both food and energy prices at the world stock markets, and this puts pressure on spatial structures. If the shocks are fast and high, adaptation may be impossible and shock will persist. This took place during the early 1990s in the former USSR, where after transition to world price for oil in domestic markets existing spatial infrastructure became suboptimal and resulted in persistent crisis, leading to deterioration of both industry and agriculture. Russia is the largest country and thus has large resource endowment per capita, but it has too low population density. Due to large distances it might be optimal to reduce transport cost either by fuel subsidy or higher competition. This will work also against disintegration of the country.

**JEL classification:** R14, R23, R40, R48

**Key words:** urban, rural, population density, prices, transport, transition

## 1 Introduction

The world is evolving with time, with the change of population, GDP, energy consumption, price indices and other parameters. But spatial patterns are also changing: people migrate from rural to urban areas, cities grow and for some of them this growth seems to have no limit. The process of population and GDP growth is accompanied with urbanization. Hence, cities should have attractive potential. It has its origin in scale economies but congestion limits this process. So far, urbanization seems to be irreversible. But there might be conditions for return migration to rural areas.

Global evolution has different temporal scales. Any process can be decomposed into trend, cycle, and random components. The response of economy to temporal shocks has some typical duration. It can adjust to slow change, but fast change typically causes a crisis. Recently we observe both a positive trend and substantial volatility in the price indices for food and energy (see Figure 2). Is it easy to adapt to those fast changes?

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Figure A.1 (in the Appendix) shows that the perceived adaptation costs can be very high, comparable to adaptation to global warming. The negative impact of energy price volatility is perceived to be much higher than for other commodities and for consumer goods.

Economic theory typically studies spaceless economy, while regional science also accounts for spatial effects. Adding space to the model allows for the tracking of the location of buildings and people. Typically relocation of people as a response to shock is a much faster process than reconstruction of buildings.

When we analyze economic geography, we have to distinguish between infrastructures (buildings, roads and other human-made landscape change) and structures (location of people, occupation, etc). Contrary to other economic markets, where adjustment to equilibrium is often costless, change in infrastructure is very expensive, while population movement is also relatively expensive. That is why we should not expect much change in infrastructure in the short run, while structures (location of population) will react to price shocks earlier. While price change effects are substantial, they can be masked by other economic factors and by the frictions related to high cost of mobility. Besides that, there is uncertainty about shock persistence (that will limit mobility of a rational agent).

This paper tries to find out if changes in food and energy price indices can create such incentives for relocation in space. Russia is an important example because it has experienced a severe and persistent rise in the relative index of energy prices and transport costs during transition and was not able to fully adapt to it in the period of 20 years. It is also an important example because of its huge territory and low population density making the role of transport costs highly influential. This paper has two simple models deriving optimal location of population across rural and urban areas on one hand, and the optimal location and size of plants as the function of scale economies and transport costs on the other.

Reality is always more complex than the models, which is why it does not make sense to make models too mathematically complex. The goal is to explain real phenomena. Here the goal is to stress high vulnerability of spatial structures to the shock in transport costs that are linked to the shocks in the energy price index. Russia has experienced such shocks twice – in the 1990s, after transition from regulated price of gasoline to the world price, and today, when it is subject to the current oil price volatility. While the model assumes a representative agent and city of one type, a real shock in the energy price is also an income shock for oil exporting economies such as Russia. However, while a change in taxes might counterbalance the benefits from a lower oil price, it does not translate into lower domestic transport cost[1].

Some authors (Robert, Lennert 2010) argue that peak oil will also have a persistent negative shock on the economy, causing people to incur high costs in the short run and even higher costs to relocate to smaller cities in the long run. The Russian experience is important to keep in mind to understand what might happen then.

This article is mostly theoretical but also presents some stylized facts that are less known in regional science literature, especially about the evidence from Russia during the transition period. Most of the economic literature assumes equal access of all participants to the market. However, there is an asymmetry between them and it is related to transport costs. While there are many microeconomic studies about urban space, rural space is much less studied (although von Thünen has started its modelling already in 1826). The areas with low population density are especially important in the case of Russia, because high transport cost can even shut down some sorts of economic activities there.

The first goal of this article is to investigate the influence of changes in global price indices on spatial structures (city sizes and rural population density). Another goal is to explain recent changes in the population location and its activities in Russia, its connectivity, and to suggest policies that could improve those structures.

First, a simple model of optimal city size is suggested. The explicit dependence of population size in a city on energy prices is of special interest. The reason is that we have observed a positive trend of energy prices between 2000 and 2014. Moreover, if peak

[1] In February 2016 Vladimir Putin approved plan to raise domestic tax rates on gas and diesel by nearly 25 percent; see http://www.cnbc.com/2016/02/29/russia-hikes-gas-tax-25-in-revenue-boosting-bid.html

oil arrives, it will reinforce this tendency. The idea that optimal city size under peak oil should be smaller than now was already discussed in the literature; see Robert, Lennert (2010). Here this result will be obtained formally in the model of Section 3. Next, in Section 4, the optimal size of small farms for self-employed peasants is studied. The result depends not only on the country's territory and population, but also on price indices for food and energy. Section 5 studies equilibrium between rural and urban areas and its sensitivity to future peak oil. Section 6 discusses to what extent price volatility can result in changes of spatial patterns of economic activity. The case of Russia in the 1990s is an important example investigated in Section 7. Some policies are also suggested. Section 8 concludes.

## 2 Literature Review

Classical regional science studies the question of optimal allocation of economic activity in space, and this paper is a contribution to this direction. Some assumptions are similar to those used in urban economics but some differ. The assumption of space continuity and two-dimensionality is crucial here. Contrary to many other papers, space plays a role not only for transport costs but also for modelling of land which is an important input to the agricultural production function.

There exist several trends in economic literature that address location choice and account for transport cost in economic modelling. Urban economics starts from the works of Alonso (1964) and many other authors, and focuses on commuting transport cost that drives land rent.

Central Business District model with inverse dependence of land rent to the distance to metropolitan center was suggested by Mills (1967) and later elaborated by many authors, including Fujita (1989). Henderson (1974) has studied optimal city size and elaborated general equilibrium model that explains variation of cities by size. There are many followers of his approach with different mathematical set up. Each city is a balance of agglomeration and congestion forces that results in some equilibrium.

The concept of the existence of a unique optimal city size obviously does not reflect reality and thus has been criticized by different authors. Richardson (1972) finds the attempt to equalize city size foolish, because the variety of optimal forms can exist. Capello, Camagni (2000) elaborated this idea and argue that the efficient city size depends on what it produces. They confirm the existence of economies of scale but only up to some level. Then structural readjustment and linkages with other cities (polycentric urban system) start to play their role.

Many authors address the issue of utility in cities. While high land rent increases the value of housing for sale, it is not translated into utility of a resident but rather has cost for him. Royuela, Surinach (2005) present an empirical study of utility of citizens in Barcelona. Their approach to optimal city size is based on the maximal difference between aggregate agglomeration advantage and location cost curves. Mascarilla-i Miro, Yegorov (2005) use the similar idea in theoretical form and derive the attractiveness of a city as the function of its population and studies the equilibrium split of population across cities.

Castells-Quintana (2015) empirically finds that urban concentration may not drive economic growth. This suggests that urban structures may react negatively to shocks. Yegorov (1999) studied the equilibrium mapping of the population with different income into dachas (small and standard plots of land with summer housing of controlled size) owned by many citizens in the USSR and the shock to this spatial infrastructure imposed by a shock in transport costs in Russia after transition.

Yegorov (2005, 2009) elaborates the concept of the economic role of population density. Rural population density can influence economic growth. There exists an optimal population density for resource based economies that in reality differ across countries depending on their individual characteristics. Too low of a population density gives high resource endowment per capita but there is a problem in building a sufficiently dense road network.

Spatial structures are sensitive to changes in economic parameters. Urban economics

with its concept of central business district (CBD) derives equilibrium location of citizens as an interplay between location rent and transport cost. If transport costs grow, residents at the city periphery will suffer more and may have an incentive to migrate to other cities (if such an option exists). Such a scenario will be considered further, in Section 6.

There are some studies about the influence of a shock in transport costs to both infrastructure and location of people. Russia is an important example because it has low population density and thus large distances covered by each citizen annually on average. Kauffmann (2007) documents the dynamics of the relative index of freight transport costs in Russia after transition, based on Goskomstat data. The ratio of transport costs to other costs jumped from 1 in 1991 (reference year) to 5 in 1992, then dropped slightly in 1994 but has never dropped below 3 between 1992 and 2005. Hence, it was not temporary but a permanent shock. There was a high correlation between those changes and electricity prices. Domestic prices for gasoline in Russia had a similar evolution after the move from domestic to world price for oil since 1993.

This shock was indeed important for freight, especially over long distances, but it was much less pronounced for the cost of using public transport in cities. While the relative change of those prices was of the same order, in the 1990s the personal transport bill in Russian cities was still affordable (contrary to negligible before 1991). However, the tickets from village to regional centers became prohibitively expensive.[2]

## 3 Simple Model of an Optimal City Size

While there exist many complex models of agglomeration, this article will deal with rather simple one. It is well known that historically cities were producing industrial goods, contrary to rural areas producing agriculture. However, in the last decades services started to dominate in the GDP of many countries. While they can be produced in all locations, the dominant share of services is still produced in cities. A city of larger size is characterized with larger population and higher variety of skills. Some services (like hospital, stadium and theater) require some minimal population threshold to start their activity. Thus, a larger city will have more variety of services and thus will produce a higher service GDP per capita. There are also scale economies for infrastructure cost (network of utilities, roads) in a city. They bring scale economies to industrial production. Since many economic activities in cities have scale economies, there is agglomeration force working in the direction of city growth. But at the same time there exists an opposite force coming from general congestion. A simple way to model it is to consider central business district model (CBD). For simplicity, radial symmetric city (of radius $R$) with a priori identical agents having land plots of equal size, $b$, is considered. Let $H$ denote construction costs of a basic house (that does not depend on location).

It is assumed that the price of industrial and service output is normalized to one, while the price index for energy, $E$, and food (agricultural output), $A$, can vary.

The utility of an agent in a city with population $N$ and radius $R$ can be also viewed as city potential. While there exists literature on CBD (see, for example, Fujita 1989), the model employed here comes from Mascarilla-i Miro, Yegorov (2005), because it is mathematically simpler and also takes into account city attractiveness due to scale economies. This model is a mix of micro and macro approaches. Urban citizens live on quite limited territory and thus are engaged in production activities that require little amount of land: industry and services. At the same time living in a city gives some scale economies related to pooling skills, saving on infrastructure per capita and others (Mills 1967, Henderson 1974, Capello, Camagni 2000). Scale economies here are modeled in a simple way like nonlinear return to population size. Their microeconomic origin can include more investment, attracting talent, scale economies in pooling labor market, etc. At the same time, costs of living in a city are modeled in a way traditional for urban economics; the sum of rents plus commuting. This simple set up assumes constant land plot per capita in a city[3], abstracting from coexistence of multi-story buildings

[2] "Financial Times" was publishing in 1995 the case: in the home village of Gorbachev monthly wages were only \$6, while the bus ticket to regional centre was \$4.

[3] This assumption of fixed land plots differs from many models in urban economics, but is kept here

and different land endowments due to wealth differential. It can also be justified by the impossibility of fast change of the whole city plan as a reaction to price volatility. Thus, utility is postulated by the formula

$$U = BN^{\epsilon} - \tau R - H \tag{1}$$

where $\epsilon > 0$ is the scale factor and $\tau(E)$ denotes transport cost per unit of distance, that positively depends on energy price index, $E$. To make agents indifferent across locations in a city, the sum of transport costs to commute to CBD and rental price of a flat (sum of construction costs and location rent) should be constant. Assuming rental price at the edge of a city to be zero[4], we get $\tau R + H = const$, and this value represents cost index of living in a city. Since the territory of radially symmetric city equals to $\pi R^2 = Nb$, where $b$ denotes area occupied by a person, we can express $U$ as the function of $N$:

$$U(N) = BN^{\epsilon} - \tau \left(\frac{Nb}{\pi}\right)^{1/2} - H \tag{2}$$

The optimal city size can be obtained by differentiation of (2) w.r.t. $N$, giving its optimal value:

$$N^* = \left(\frac{B\epsilon\pi^{1/2}}{\tau b^{1/2}}\right)^{1/(0.5-\epsilon)}$$

It is easy to show that the optimal city will be of finite size only for relatively small scale economies: $0 < \epsilon < 1/2$. This model allows for the coexistence of cities of different sizes due to differences in scale economies (here parameter $\epsilon$) for different productive activities but this is acceptable for our study.

Further we study the comparative statics. The partial derivatives for the optimal city size of type $\epsilon$ with respect to $b$ and $\tau$ are both negative:

$$\frac{\partial N^*}{\partial b} < 0, \qquad \frac{\partial N^*}{\partial \tau} < 0 \tag{3}$$

For us it is important that growth in transport cost leads to decline in the optimal population of a city. For $\epsilon < 1/2$, optimal population size depends on $\epsilon$ positively. The richer the population, the larger land plot per capita, $b$, is demanded. This lowers the optimal population of a city in developed economies.

The role of transport costs is also important. While this is not explicitly accounted for, transportation time also influences utility. Technological development in transportation reduces it, and thus makes CBD accessible from larger distances; this makes city size larger. On the other hand, congestion in the form of traffic jams increases this time, and thus reduces the radius of optimal city.

Sinced $\frac{d\tau}{dE} > 0$, it can be concluded that the growth of energy prices leads to a decrease of an optimal city size. Further we focus only on the case of $\epsilon < 1/2$, where finite equilibrium city size exists.

## 4 Optimal Agricultural Density

Rural population density has quite high variation across the globe, from 500 people per sq. km in fertile lands in India and China to less than 1 person per sq. km in rural Australia, Canada and Siberia. There is no unique equilibrium population density; it depends also on regional factors. However, the density in a particular region may be subject to shocks.

The model of this section is also highly stylized. Since rural land rent is typically much lower than urban, it was neglected in the model of a city, but is kept here. In the case of Russia is also can be neglected, but we keep it for generality.

for several reasons: a) mathematical simplicity, b) typical evidence about land plots in the USSR, c) elimination of multiplicity of equilibria.

[4]More precisely, it should be equal to agricultural rent, but since it is typically much lower than urban land rent, it is neglected for simplicity.

The paper focuses on the role of population density, and it is accounted for in the model of optimal land plot for agriculture and finally utility of farmers. It is assumed that all land has equal square plots with the side r and hence size $S = r^2$ and is owned by farmers. Depending on plot size, they can choose different cultures and technologies. For modeling agricultural density, consider a Cobb-Douglas production function in agriculture, based on labor ($L$) and land ($S$): $Y = AL^{1-a}S^a$, where $A$ stands for the food price index. A farmer is assumed to supply inelastically one unit of labor and applies it to land plot. Substitution between land and labor is crucial. Depending on land plot size, a farmer can choose between different technologies. For the same value of output growing berries requires less land but more labor than wheat. There are decreasing returns to scale in agriculture to land plot size if only one farmer works there. At the same time, harvesting on a larger land plot involves higher transport cost (see Yegorov 2009). What are the main costs? There is land rent, $R$, and there are costs (like ploughing) that require energy input; both are proportional to land size $S$. There is also the cost of delivery to the market, which is proportional to the distance, $d$, to this market and unit distance transport cost, $\tau$, which depends positively on energy price, $E$. Hence, the profit of a farmer is given by:

$$\pi = AS^a - (R + cE)S - \tau d \tag{4}$$

Profit maximization for equation (4) with respect to land size, $S$, leads to equation

$$AaS^{a-1} = R + cE \tag{5}$$

that gives optimal plot size, $S^*$. In the case $a = 1/2$, the expression for $S^*$ is very simple:

$$r^* = S^{*1/2} = \frac{A}{2(R + cE)} \tag{6}$$

This optimal land plot for a farmer depends positively on the food price index and negatively on the land rent and energy price index:

$$\frac{\partial S^*}{\partial A} > 0, \qquad \frac{\partial S^*}{\partial R} < 0, \qquad \frac{\partial S^*}{\partial E} < 0, \tag{7}$$

We can see from (7) that when food and energy prices change proportionally, we have opposite effects on optimal land plot and thus small overall effect. However, very often they change disproportionally and this can cause a negative effect on agriculture (especially when energy prices grow much faster than food prices).

If we have a fixed rural population, $N$, and all rural arable land $Q$ is divided equally among them, then a plot per person is $S = Q/N$. The corresponding rural population density is then $\rho = N/Q$. Using formula (6), we can find optimal population density,

$$\rho^* = \frac{1}{S^*} \tag{8}$$

Note that the signs of partial derivatives for optimal rural population density, given by (8), with respect to $A$, $R$ and $E$ are opposite to those given by (7). If $\rho < \rho^*$, there is unused arable land and this can stimulate urban-rural migration. In the opposite case the rural area is overpopulated, and this drives urbanization.

We have a story in the spirit of von Thünen (1826), where farmers at larger distances from the city have to pay higher transport costs to bring good to the market but can enjoy a larger land plot. This story is only true when rural population density is low and not all arable land is developed. This is still the story of many regions in Russia, but cannot be applied for fertile and populated areas of China and India, where rural land plot depends on population density and may be smaller than its optimal size. In fact, in overpopulated rural areas this makes the profit of a farmer too low and stimulates migration to cities.

Suppose that the rural population density has an intermediate value, allowing all of those who want to do agriculture to select an optimal plot. Then land rent is no longer exogenous. The rise in food price will drive agricultural rent, and prevent the farmer from expanding the size of his plot. The fall in food price as well as the growth in energy

prices will result is lowering optimal plot and can stimulate urban-rural migration but only if utility of living in a city also becomes lower. In other cases, farmers will prefer to develop only a fraction of land, saving on costs. Thus, a rise in energy prices will result in the decline of agricultural output for constant rural population. This effect is observed in Russia and will be discussed later.

Another important issue is related to the transport cost to access the market, the last term in equation (4). Here we have an important rural asymmetry between areas close to cities and areas more remote. In the second case, the cost of market access can be so high that agriculture will simply shut down being unable to produce profitably even at zero land rent. This may be a problem in the countries with low population density, like Russia. Another problem that can harm agriculture is no direct access of farmers to the market. A too high share captured by intermediaries in the final price for food can also make agriculture not profitable. One example from Russia was shown on TV in 2015: fishermen get only 30% of the final price for fish, transport cost is 10% and 60% goes to intermediaries.

### *4.1 Different Types of Equilibria*

It is possible to construct a formal equilibrium in the full space, where all land is used. Assume that all space is occupied with agricultural and urban population, but urban density is much larger, so that we can neglect the territory occupied by cities[5]. Let $\gamma$ be the fraction of rural population, $\rho$ the average density and $\rho_a$ agricultural density. Then $\rho_a = \gamma\rho$. To make agents indifferent between living in a city or rural area, it is necessary to equate their utilities from both options: $V_1 = U(N^*) = U^*$. This leads to the transcendental equation

$$U^*\gamma^a + \frac{\tau}{\rho^{1/2}}\gamma^{a-1/2} - \rho^{-a} = 0 \tag{9}$$

that can be reduced to a cubic equation for $a = 3/4$ and $y = \gamma^{1/3}$. This equation (due to special property of signs) has a unique positive root. Thus, we can find optimal split of the population into urban and rural[6].

The equilibrium location structure includes “raisins" of optimal cities in a “cake" of uniformly dispersed agricultural population. For a given total population of a country, population density in cities, transport costs, coefficient of increasing returns in city and decreasing returns on agricultural land, there exist optimal number and size of cities and optimal agricultural density.

This type of equilibrium is relevant for densely populated countries, like India and China. If the price index for food grows, there are additional jobs on the farms because it becomes optimal to have more workers per 1 hectare. Sometimes employment may be informal, and that is why legal issues about land ownership are of less importance.

The situation in Russia is completely different. Here not all arable land is used today and the problem is also in high transport cost from remote farms to the market.

### *4.2 Model Summary*

The summary of the results of those models can be formulated as a following proposition.

> **Proposition 1**. There exist optimal size of cities and agricultural land plots developed by one farmer (gives scale economies and land productivity). They depend on global price indices for energy (given transportation technology) and food. Changes in those price indices make those structures suboptimal. In particular, growth in energy prices makes optimal city sizes and plots developed by one farmer smaller.

[5]For most of the countries this is a valid assumption, since typical urban density is about 10.000 people per sq. km, while rural density can be as low as 1 person per sq. km but sometimes reach 100 and more.

[6]More detailed derivation is presented in Yegorov (2011).

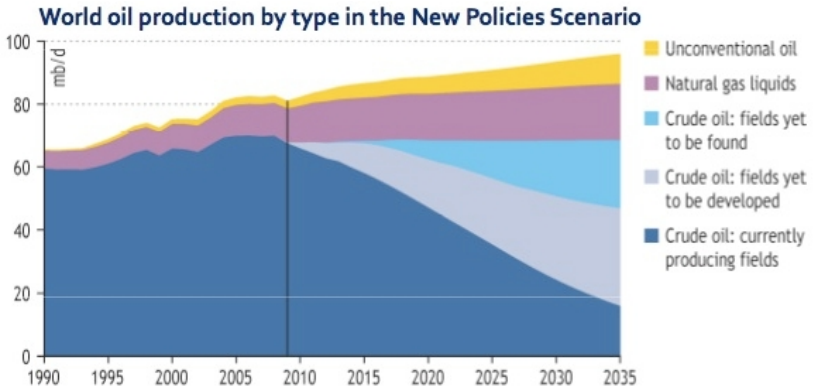


Figure 1: Future oil production forecast
Source: The International Energy Agency's (IEA) World Energy Outlook 2010

## 5 Spatial Urban-Rural Structure and Peak Oil

### *5.1 Equilibrium and Relocation Cost*

In theory, such an equilibrium between urban and rural areas should exist and it should give the same utility for living in a city and working in manufacturing as it does for living in a rural area and working in agriculture (Yegorov 2006). Most of the time we observe disequilibrium, and it stimulates rural-urban migration. However, an energy price shock leads to decline in utility in cities due to high commuting costs.

Transition across equilibria is not costless. Let $B$ denote annual benefit from either migration or building new infrastructure (comparing to current utility, $B = U(n) - U(o)$, $n$: new, $o$: old) and $C$ denote the fixed cost of such change. Let $T$ denote the expected time span of current sub-optimality due to price shock. Then transition to new (infra)-structures will take place only if $BT > C$. Note that $C$ is lower for migration than for rebuilding; it depends positively on interest rate.

In the short run no new buildings can be constructed, and citizens have two options: to suffer rising costs or to move to rural area. While richer household can afford staying, poorer can move to rural area, where commuting is cheaper. If the food price index grows faster than energy, they can engage in agricultural activity. Since optimal land plot there also becomes smaller, there might be land for them to work[7].

This effect is opposite to urbanization. In the history of Russia, it was observed two times. First, after the civil war of 1918-1920, industry was destroyed and cities lost scale effects attracting people. The second time was in the 1990s, after transition to a market economy accompanied by drop in GDP per capita. Many urban citizens had small land plots (dachas) and spent some time doing small agricultural activity.

### *5.2 Change in Energy Price Index*

Since oil is an exhaustible resource, sooner or later its production will peak. Scientists have different opinion about this timing, but most of them agree that it will come in the first half of the 21st century. According to IEA data (see Figure 1), the discovered conventional oil fields have already peaked, and the hope is for yet undiscovered fields and non-conventional oil. Substitution of oil for renewable energies in transportation goes very slowly and thus peak oil can come unexpectedly causing very high rise in oil prices.

The paper of Robert, Lennert (2010) analyzes the impact of oil peaking for Europe. One of their results is that oil peaking will increase prices and reduce transportation, and this will restructure the whole urban system. In particular, sub-urbanization will be reversed and people will move to more compact cities.

[7] It is not very important whether this land is owned officially or not. Rising in food price index will create additional jobs in agriculture because more intensive land development becomes now optimal. In the case of Russia today, many people are officially unemployed in agriculture but they can work on small land plot (dacha) and use this output mostly for domestic consumption.

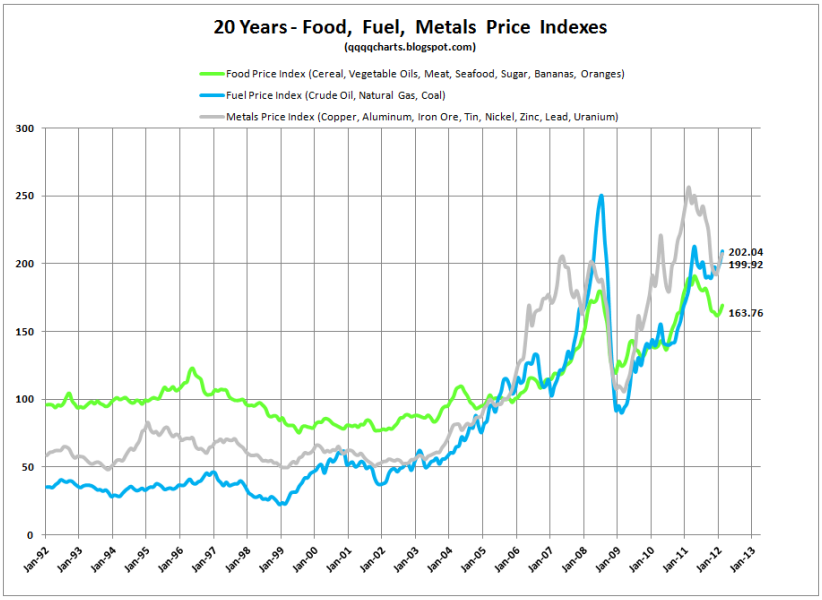


Figure 2: Indices for energy and food prices
Source: http://qqqqcharts.blogspot.co.at/2012/03/20-years-food-fuel-metal-price-index.html

Indeed, the result of Section 3 shows that the optimal city size declines with the rise in transport cost caused by the rise of energy (and in particular, oil) prices. Commuting inside large cities will become prohibitively expensive. Market forces will cause both migration to smaller cities (see Mascarilla-i Miro, Yegorov 2005) and the decline of land rent in a large city until new equilibrium will emerge.

In line with our model, the rise of oil prices will make the energy price index higher. This will make transportation (and harvesting) more expensive. In order to keep rural areas stable, there will be an upward push in the food price index. If the ratio of $A/\tau$ remains constant, nothing happens with optimal rural density. That is why this shock will harm mostly urban population, and it will relocate from large to smaller cities. Since rapid construction of new smaller cities is hardly possible, in the short run there might be reverse, urban-rural migration.

## 6 Reaction of Spatial Patterns to Price Volatility

By spatial patterns we understand both infrastructures (buildings, etc.) and structures (location of population). Price variation over time (see Figure 2) can be decomposed into trend, cycle, and stochastic volatility of high frequency. While both prices of energy and food influence optimal location patterns, relatively high cost of mobility prevents reaction to changes of high frequency.

Note that change in price indices for energy and food is typically not driven by the changing demand (scale will then be modest) but by financial speculation. However, the cost of adapting to such changes is likely to be high (see Figure A.1 in Appendix), and comes mostly due to difficulty of adaptation of spatial patterns.

Trend component gives an incentive to change not only for population location, but also for infrastructures. City growth usually has a planned and random component, and reacts better to positive economic changes. If some spatial infrastructure becomes obsolete due to a bad price shock for its ecology (next section will show an example), it may be too costly to change it, even during a time horizon of 10-20 years.

As we know from business cycle literature, population reacts to business cycles by spatial and occupation mobility. That is why we can expect some rural-urban (or even reverse) migration as a reaction to both trend and cycle in prices for food and energy.

When we have co-movement in food and energy prices, we can expect little reaction of agriculture (because production there depends positively on food prices, but negatively

on energy). On the other hand, urban utility is negatively affected by growth of the price indices in both energy and food, and such positive co-movement can be a big shock for cities, especially in less developed economies where food and transport represent a very high fraction of household expenditures.

The following testable hypothesis can be formulated.

> **Hypothesis**: We can observe some changes in spatial structures only in the following cases: a) transition is slow, so that only new construction will take into account the existing price trend, while old infrastructures will not adjust, b) transition is fast (like peak oil) but is irreversible ($T \to \infty$, so that change is better at any cost, and c) adaptation cost is low comparing to benefits during expected shock duration, $T$.

Price volatility has a negative effect on the economy, because adaptation is costly and often not feasible. Not only trends and cycles in global prices for oil and food matter, but also a country's laws regarding subsidies and taxes. The positive trend in oil price in the 21st century deteriorated utility in cities, but in the EU it was less pronounced, because the main component of gasoline price is tax. In a similar manner, a drop in oil prices in 2014-2015 gave less additional utility to citizens and farmers of EU, comparing to countries with low taxes. Some oil producing countries have a domestic price for gasoline well below the global price. This eases agricultural activity but elimination of such subsidies will put their infrastructures under shock. This happened in Russia during transition to a market economy, and this case will be considered in more detail.

## 7 Russian Changes in Prices, Structures, and Policies

There have been many changes in Russia after transition to a market economy in 1992. Since there was no free market before 1992 and prices have been set using administrative methods, economists often do not even compare those periods. However, wages and prices existed in both periods as well as free mobility, and thus people could choose their location optimally in both periods.

There are several factors that influence the decisions of the Russian population. Too high transport cost and high wage in Moscow (driven just by location of financial flows, exogenous to this model) have stimulated migration there. At the same time, urbanization level did not grow after 1992 and many people were actually living in rural areas to survive.

Two effects are especially important: a) existence of optimal spatial infrastructures before transition (Subsection 7.1) and b) the persistent shock in energy prices (7.2).

### *7.1 Optimal Plant Size as the Balance between Scale Economies and Transport Cost*

In Soviet time, many giant plants were built, also because of scale economies. If we consider some scale economies in manufacturing that are balanced by the transport costs for the spatial area where inputs are harvested and the final good is distributed, we have mathematical model similar to one considered in the Section 3 (it is fully described in Yegorov (2009) but is given here shortly). Consider an optimal planner problem to invest fixed capital, K, into some industry and to choose a number of plants with scale economies ($c > 0$) that collect resources and sell the output at the uniformly populated territory around them. In this case the average distance of transportation is proportional to inverse square root of $N$. Formally, the problem is to maximize the benefits proportional to the total output minus cost of capital and transport:

$$\max_N \left[ AN \left( \frac{K}{N} \right)^{1+c} - \tau N^{-0.5} - \gamma K \right] \tag{10}$$

After optimization we get the optimal number of plants to be proportional to the square of transport cost. The lower this transport cost, $\tau$, the larger will be the size of optimal plant and the lower will be their quantity $N$, and this was the case of the

USSR with its subsidized transport. So, if it was necessary to produce some output $Y$ of particular good to satisfy the demand of the USSR (which was to some extent a closed economy[8]) given the price of output, $A$ (also fixed), it was indeed optimal to build few super-giant plants, say 10, at the distance of about 1000 km from each other.

Now it is documented, that the (inverse) price ratio $\tau/A$, has increased by factor 3-4 during the transition and persistently stayed at this level thereafter (see Figure 3). This means that spatial industrial infrastructure of Russia is under persistent price shock since the 1990s. Under new conditions it would be optimal to have smaller plants with smaller market areas around. Especially this is important for cheap goods (like cement, wood, etc.) for which freight has a substantial fraction of the total price. Since rebuilding of all industrial infrastructures (just to change locations and capacity) is too high of an investment for any country, it can be done only in the very long run. Meanwhile, plants remain unprofitable. Only transport subsidies (at least partial) could have kept those industries alive, but this has not been done. The bankruptcy level in the non-extracting industries in Russia in the 1990s was very high. Nowadays there is neither a transport subsidy policy nor planned investment to rebuild this infrastructure on a new optimal level. Due to high transport costs not only has interaction between regions declined (both as trade and passenger trips) but there was also extensive migration to giant urban areas, especially to Moscow. While congestion factors in Moscow are high, the negative pushing effects from regions of Russia dominate.

### *7.2 Russian Transition Shock and Impact on Relative Price of Energy*

Availability of cheap transport is very important for economic success of a country. Stratfor[9] has proved that the economic success of the USA was highly determined by the presence of Mississippi river basin, with both cheap water transport and one of the largest global basins of arable land. In the case of such large territory with dispersed population like Russia cheap transport becomes crucially important. The Volga River basin (smaller than Mississippi but still the largest in Europe) gave high growth potential in the 19th century, but the development of railroads was needed for the connection with other (especially Asian) river basins. While rail transport is about twice as expensive as river (see the reference to Stratfor's article above), it allows to connect all points in a network, although at higher price. In the time of the USSR transport had been subsidized (the country kept domestic prices of gasoline and electricity at regulated level, below the world price), and this allowed for the integration of Siberia into an economic zone at the higher scale than similar territories in Canada.

Transition in Russia has caused substantial growth in relative energy and transport prices (see Figure 3). This caused a shock for agriculture, and it went into gradual decline (see Table 1). For whatever reason[10], Russian agriculture could not benefit from the rise in the food price index. However, this was also a shock for industry. The urban population has experienced both shocks (transport and food) and their utility has declined in the 1990s. Many people were using dachas (small land plots of about 0.1 hectare given to citizens in Soviet time for symbolic price) to help family budget by small crops, but this was mainly an autarky (self-consumption) due to high transport costs and small volumes.

Not all evidence about the decline of agriculture in Russia is provided by official statistics. Academician V. Kashin writes that after transition, the quantity of labor force in agriculture has declined from 6 million to only 1.17 million in 2015. About 5 million people are officially unemployed but work on small land plots for personal consumption manually without machines. While their productivity is about 1/8 of one in the EU, they still produce about half of meat and milk and about 90% of vegetables[11].

[8] In the former USSR import share of the goods consumed by household was much smaller than in Russia today.

[9] The geopolitics of the United States, Part 1: The Inevitable Empire. 4 July 2015. https://www.-stratfor.com/analysis/geopolitics-united-states-part-1-inevitable-empire (accessed 30.03.2016)

[10] Perhaps too expensive credit or too high margin of intermediaries in food market, but mismanagement can also be one of the reasons.

[11] Source: blog http://scherrina.blogspot.co.at/2015/08/blog-post_30.html (accessed 16.03.2016)

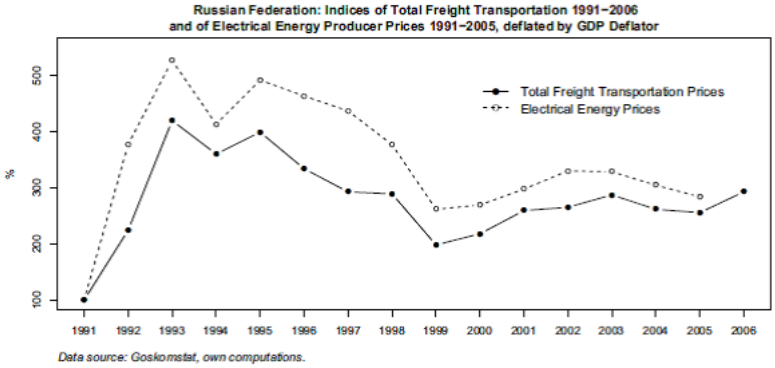


Figure 3: Change in relative transport cost in Russia after 1991
Source: Kauffmann A. (2007)

Table 1: Basic data for changes during transition in Russia

| Year | Urban population share,% | Price of gasoline, USD | GDP per capita, USD | Agriculture share of GDP, % |
|---|---|---|---|---|
| 1990 | 73 | $< 0.1$* | 3485 | 16.6 |
| 1995 | 73 | 0.35 | 2665 | 7.2 |
| 2000 | 73 | 0.33 | 1771 | 6.4 |
| 2005 | 73 | 0.66 | 5323 | 5.0 |
| 2010 | 74 | 0.84 | 10675 | 3.9 |

Source: World Bank, http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS
* Exact value is not available due to multiplicity of exchange rates before 1992

### *7.3 Too Low Rural Population Density in Russia*

The difference between Russia and other countries is in its low population density (see Figure 4). This may have positive and negative effects (see Yegorov 2009). On the positive side, there is high land endowment per capita, allowing the harvesting of more mineral resources and the production of more agriculture. On the negative side, the population is too low to build a dense road network, and still declines. Also, low agricultural productivity in most Siberian areas leads to larger territory needed to produce the same quantity of output. Hence, the fraction of energy cost in agricultural output becomes higher. This poses a persistent problem for regional and rural development in Russia.

Figure 5 shows the global railroad map. Russia has many km of railroads, but their density even in the European part is below that in Western Europe, while the Siberian part has only the Trans-Siberian railroad (built in 1916) with only few secondary roads without any dense network. Absence of a dense road network (paved roads in Siberia are also not frequent) leads to low access to remote resources and the necessity to transport them without roads. This exercise is prohibitively expensive. Yegorov (2005, 2009) has shown that too low population density can be an obstacle for extensive and profitable land exploitation, and also can harm economic growth. Population growth in rural areas in this case might be a positive externality causing growth in productivity.

Another problem in Russia is relatively low land fertility. In most of its regions (apart from North Caucasus), the yield of wheat is lower than in Western Europe (see Figure 6). While the USSR was the major global producer of wheat, Russian position today (as well as Ukrainian) is much lower. In 2012, Russia produced only 37.7 mill. tons of wheat and occupied the 6th position in the world[12], after EU (134.5), China (125.6), India (94.9), USA (61.8) and France (40.3). Thus, Russia does not use its territory efficiently. USSR had much higher agricultural potential. Wheat was produced not only for bread, but

[12]Source: http://en.wikipedia.org/wiki/International_wheat_production_statistics

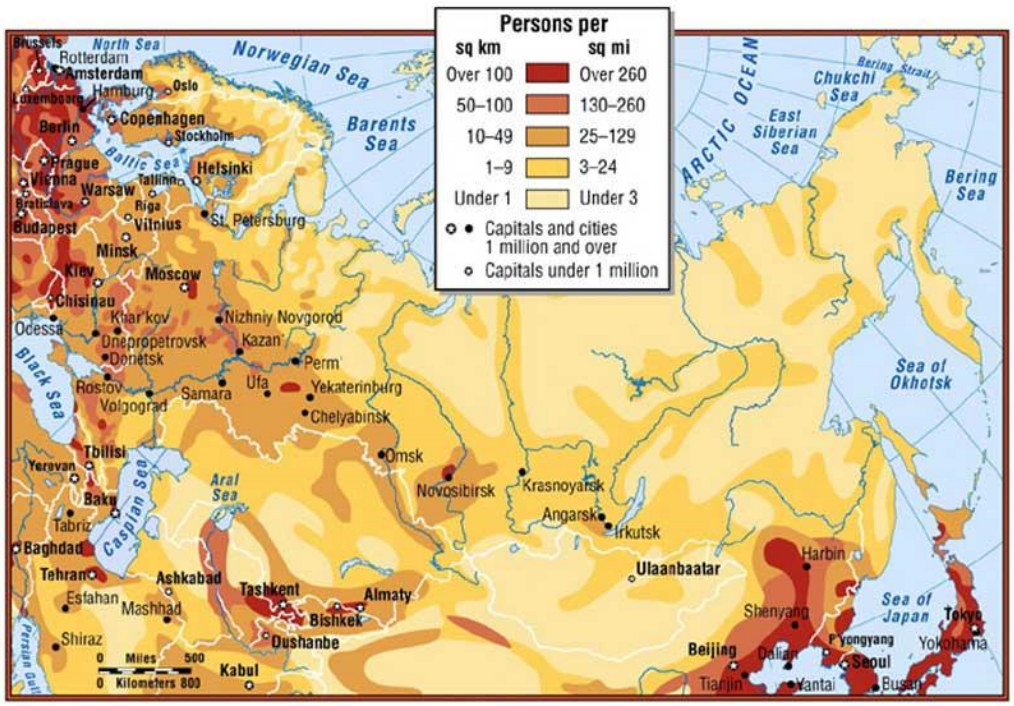


Figure 4: Map of Russian population density. Siberian density is often below 1 per km$^2$
Source: http://www.roebuckclasses.com/maps/placemap/russia/russiapop.JPG

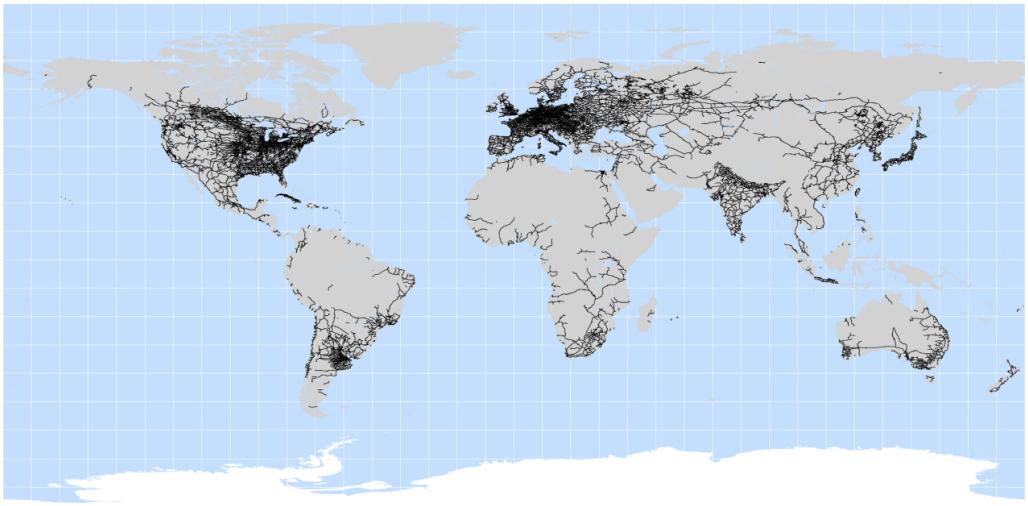

Figure 5: Global map of railroads shows huge heterogeneity in the spatial density of railroads. Although Russia has a lot of km of railroad, its spatial density is well below European
Source: http://bioval.jrc.ec.europa.eu/products/gam/images/large/railways.png

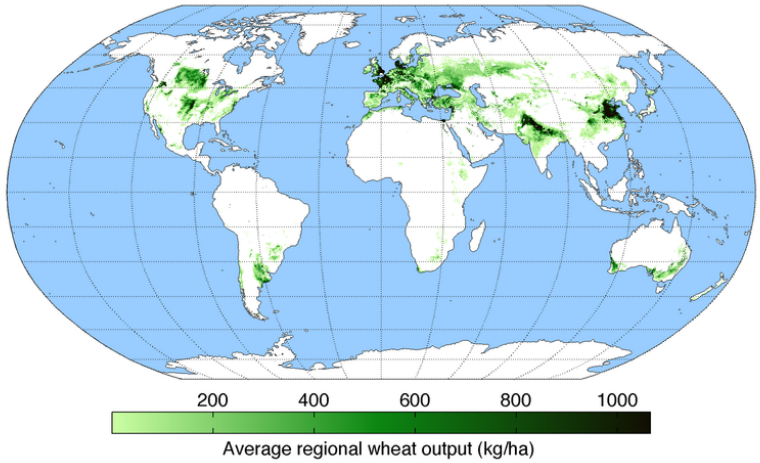


Figure 6: Global map of wheat yield (kg/ha) also shows high spatial variance, with maxima in EU, some areas of China, India and the USA
Source: http://en.wikipedia.org/wiki/File:WheatYield.png

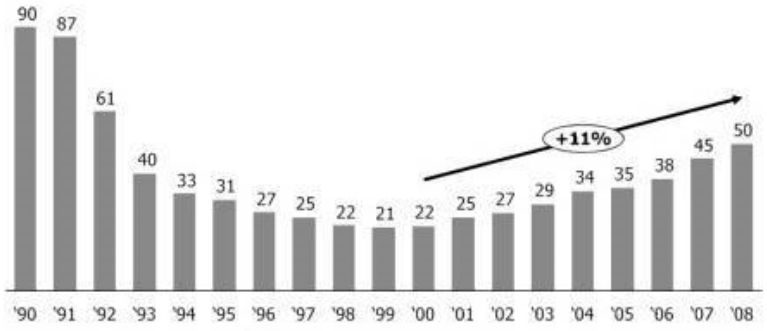


Figure 7: Dynamics of air passengers in Russia (in millions per year), 1990-2008
Source: Savelev (2010)

also for feeding animals. Now Russia imports a high fraction of consumed meat. China might require import of food in future, and this could be alternative source of income for Russia, when oil production will decline.

### *7.4 Disintegration of Russian Air Traffic and Threat for Integration*

Air transport plays high role for the passenger transport. In the USSR the air transport was well developed. Labor policy has moved population over vast territory, and high demand for connection and cheap (subsidized) gasoline had driven up the market for air transport. After the dissolution of the USSR in 1991 and market reforms it went into deep decline and started to recover only after 1999 (see Figure 7).

Lukjanov (2008) presents the following data. The quantity of air passengers continued to decline between 1996 and 1999 (from 26.96 to 21.47 million) and started to grow only afterwards. The decline after dissolution of the USSR has been much more substantial: in 1990 there were 90.8 million air passengers[13]. Contrary to foreign air companies, the cost of fuel is the main cost component in Russia. For example, in 2006 Russian air companies spent 40% of their costs on fuel, comparing to only 12% for Delta Airlines. Savelev (2010) shows that between 2002 and 2007, the price of air fuel in Russia grew by 160%, while the ticket price by only 120%. This shows that fuel price is the main driver of transport cost for air passengers in Russia.

[13]Source: А.Б. Фрайман. Авиаперевозки советского периода. http://www.iatvt.ru/doc/05-article, statistics 1990, 1.doc

Table 2: Evolution of domestic air passenger flow in Russia between 1990 and 2012

| Direction of flight | 1990 | 2012 |
|---|---|---|
| To/from Moscow | 26% | 75% |
| Regional airlines | 46% | 22% |
| Local airlines | 28% | 3% |

Source: Koroteeva (2015)

Table 2 shows that the topology of air traffic has changed. Now most of the regions are connected only with Moscow, while in the USSR they were connected between themselves.

There are two major microeconomic reasons for those changes. The first is substantial increase of relative transport cost in Russia after economic reforms of 1992: it was a shock of about 450% relative price rise in 1992, but the ratio stabilized at about 250% after 2000 (see Figure 3). The second is in higher income disparity. While in the USSR the ratio of income of the top 10% to the bottom 10% was only 3.5 (Atkinson, Micklewright 1992), after transition it has grown to 15 and remains at this level for many years. Hence, air transport became non-affordable for the majority of the Russian population. Demand shrinkage was especially pronounced among regions, where operation of even one air plane became non-profitable and thus was cancelled. This poses a threat for Russian regional integration.

Today the quantity of air passengers has increased, although not to the level of the USSR. Domestic air transport is still expensive and not affordable for a large fraction of the population. There is low competition across Russian airlines, while western low cost companies (like Ryan Air, Euro Wings) are not coming to Russian cities apart from Moscow. Low cost flights are almost unknown among Russian air companies. They may prefer to satisfy demand of richer populations and sell few expensive tickets because income distribution in Russia today is more unequal compared to the EU.

### *7.5 Optimal Policies for Russia*

We see that Russia is facing persistent structural shock that was imposed by the growth in energy and transport prices. At present, Russia does not extract benefits from its large territory. It was an asset in Soviet time, but now became a liability.

Table 1 shows that the share of urban population in Russia was pretty stable during the last 25 years, while there were substantial changes in the domestic gasoline price and GDP per capita (also driven by oil price volatility), while the share of agriculture in GDP was declining. This shows that the place to live has some inertia and is not subject to influence of even long term trends. However, suppression of agriculture and the end of urbanization may also reflect structural changes in transport cost. High mobility costs could be the reason of the stabilization in the shares of urban and rural population. Only Moscow is growing because of higher attractive potential that has external origin to this model (financial center offering higher wages).

We see also a decline in agriculture despite high endowment of land (also arable) per capita. Its initial decline in the 1990s could also be due to the shock in transport costs that had suppressed agriculture in the areas distant from the major cities. But its decline after 2000 when GDP per capita was growing may also reflect mismanagement.

When all of the population tend to live in cities, it does not matter how large is the rural territory. For the efficient exploitation of rural resources the policy to reverse rural-urban migration should be used. Russia should use its agricultural potential more efficiently. Now it specializes on harvesting of only non-renewable resources (oil, gas, metals) but should specialize on renewable too (agriculture, forest and fishing).

One of the policies is to return to domestic subsidy of gasoline. Fuel for agriculture and large distance transport of agricultural goods may be subsidized. Many oil producing countries still have it, although this is not an efficient use of resources. At least, gasoline should be produced competitively (any cartel agreement should be eliminated) and there should be no tax on it. Another possibility is to increase competition in transportation

to make its prices below the world level. Russia can also use the current drop in oil prices to boost domestic transportation, oriented not only on harvesting remote renewable natural resources but also on increase in passenger flow. This can also prevent Russian disintegration.

## 8 Conclusions

The paper studies the question of sensitivity of spatial location of the population to the changes in energy and food price indices. It consists of mathematical and policy parts. First, a simple theoretical model based on attractive potential of a city and cost-benefit analysis of a farm is considered. It results in finding an optimal city size and rural population density parametrically depending on transport costs.

The obtained results are further analyzed from the perspective of their sensitivity to external shocks in basic prices, like world food and energy price indices. It was shown that a rise of energy and food price alone requires change of the whole spatial pattern, which is too costly and painful. That is why peak oil might have very negative consequences for the global city network, requiring relocation and construction of new smaller cities. If food price (as return to producer) grows slower than energy prices, this causes rural shock and leads to rural-urban migration, resulting in lower rural population density than is optimal for this case.

The case of Russian transition is considered as an example of a severe shock in energy prices. It is a persistent shock for all industrial infrastructures that has resulted from a 3-fold increase in freight cost and then perturbed the whole spatial infrastructure that had been created mostly in Soviet time for subsidized transport costs. Higher transport costs (relative to composite good) in Russia after liberalization in the 1990s had several adverse effects for the economy and population. Too high transport costs made exploitation of natural resources and agriculture less profitable, especially in the areas with low population density. Overall urbanization level did not change, but it can be the effect of too high mobility cost. People migrate to large cities (the only source of attractive wages) but industry in other cities is depressed. Rural population density in Russia became even smaller because of a negative population growth rate, especially in the 1990s. All those effects contribute to a persistent negative shock for Russian economy which is one of the reasons for its crisis today.

The shocks to spatial infrastructure in Russia were not analyzed when transition policy was elaborated. Too high interest rate also works against adaptation to new environment. Now those issues have to be taken into account.

It is also important to understand that high energy price volatility poses a problem to global spatial structures. Models from this paper help to understand potential adjustments and the scale of corresponding costs.

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## A Appendix

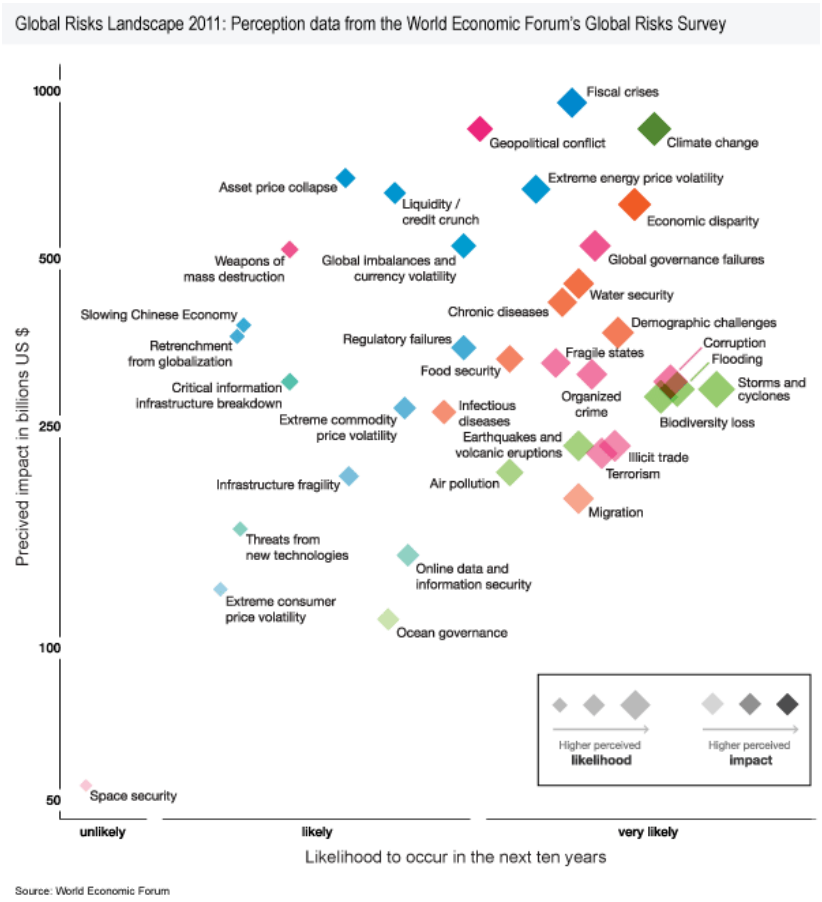


Figure A.1: Global risks: impact versus probability. Extreme energy price volatility has both high likelihood and high impact, well above volatility of other prices
Source: http://peakoil.com/forums/doomer-risk-perception-chart-t60660.html

# Resources

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# Towards A Regional Science Academy: A Manifesto

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**Abstract.** This Manifesto provides a joint proposal to create a Regional Science Academy as a think-tank support platform for a strategic development of the spatial sciences. The Regional Science Academy is a strategic spatial knowledge catalyst: it acts as a global intellectual powerhouse for new knowledge network initiatives and scholarly views on regions and cities as vital centrepieces of interconnected spatial systems. This contribution highlights its role and presents various activity plans.

*'All the forces in the world are not so powerful as an idea whose time has come'*
Victor Hugo

## 1 Prologue

*'The most dangerous worldview is the worldview of those who have not viewed the world'*
Alexander von Humboldt

Over the past months, various scholars with a deep professional interest in the spatial sciences have met in varying compositions and on different occasions to discuss the strong and weak points in the spatial sciences, in particular from the perspective of their future vitality, with a view to identifying promising opportunities that would make a difference. Their intensive discussions were prompted by a widely shared concern on the lack of innovativeness, vibrancy, and external recognition of the spatial sciences.

There was a general consensus that some sort of academic 'think tank', driven by original brainstorming activities, is a critically needed vehicle to ensure the necessary innovation and dynamics in this important field of research and policy.

Such a novel initiative should be organised from the bottom up, on the basis of voluntary efforts, and produce seminal contributions of dedicated scholars and experts for the whole world of the regional sciences. It would act as a catalyst for innovative and free academic thinking, and in the execution of its tasks be relatively independent from existing scientific organisations in the domain of the spatial sciences. The operation of such a 'think tank' initiative should not be directly controlled by the vested – though useful – interests of existing organisations and agents, but should operate at arms' length of existing bodies as a decentralised service network of scholars. It should be conceived of as a voluntary, bottom-up driven platform for the generation, identification, promotion and diffusion of new ideas in the spatial sciences, with a view to their future dynamism. The institutional organisation of this scholarly initiative should be light and flexible, and would operate most fruitfully under the wings of the Regional Science Association International.

*'The doors of wisdom are never shut'*
Benjamin Franklin

It would be called the Regional Science Academy; it would clearly have a much broader constituency and membership than the Regional Science Association International in a strict sense. It would act as a voluntary intellectual service team ('a supporters club') with the aim to strengthen the long-term perspectives and strategies of existing organisations by offering original and scholarly insights. It would share new insights from the perspective of forward-looking intellectual contributions with the worldwide regional science community in its broadest sense.

*'If we wait until we're ready, we'll be waiting for the rest of our lives'*
Lemony Snicket

The present strategy document 'Towards a Regional Science Academy' outlines the various ambitions and plans that have been formulated in cooperation with a large and varied group of founding fathers/mothers from all over the world. The focus of the planned activities will, in particular be on:

- Ideas: exploration of forward-looking and innovative regional science concepts, new spatial theory and methodology, new perspectives on policy, etc.
- People: integration of young scholars and broadening of geographical scope, so as to create new seedbed conditions for original thinking worldwide.
- Data: sharing of information in a 'big data' world (e.g. data warehousing), so as to foster worldwide cooperation among spatial scientists.

## 2 Regional Science in Perspective

*'It's not enough what I did in the past - there is also the future'*
Rita Levi-Montalcini

The broad field of the spatial sciences comprises a wide variety of (multi)disciplinary orientations and domains, such as regional economics, urban economics, geography, regional science, political science, demography, business management, transportation science, land-use planning, urban architecture, heritage management, environmental science, and so forth. This amalgam is also reflected in a great diversity of distinct and unconnected scientific and professional organisations, which are often operating in infertile isolation from each other. There is no systematic and translational synergy and coherence in planning and programming new scientific endeavours that are strategic and

long-term-oriented. This is a regrettable situation which forms a sharp contrast with many other disciplines and science domains, where 'think-tank' strategies and operations at an international level have become quite common. Lack of forward thinking – with regards to both ideas (cognitive capital) and people (human capital) – is detrimental to a field that is central to the future of our world.

The spatial future of the planet is a source of much uncertainty and deep concern for both scientists and policymakers, as is clearly witnessed in the recent Paris Declaration (2015) on climate change.

*'Imagination is more important than knowledge. For knowledge is limited, whereas imagination embraces the entire world, stimulating progress, giving birth to evolution. It is, strictly speaking, a real factor in scientific research'*
Albert Einstein

Regional science seeks to enrich the multifaceted social science research domain by coping with – and addressing explicitly – the often prevailing, but clearly restrictive assumption of a 'wonderland of no spatial dimensions' in the traditional social sciences. It started in the 1950s from a dedicated and convincing scientific mission, in which the impact of spatial opportunities on, and obstacles to, regional and urban development and of spatial interactions assumed a central place. The analytical focus through which these phenomena were investigated – usually from a multidisciplinary and evidence-based orientation – formed a distinct, prominent and recognised feature of regional science in comparison to established disciplines, such as geography, political science, urban and regional planning, transportation science, environmental science, etc. For many spatial science researchers, regional science is not their original and only discipline, but it is often complementary to their initial and single 'home discipline'. The degree of 'self-identity' of regional science – or the spatial sciences in general is generally rather low. In essence, regional science is an amalgam of various disciplinary approaches with a core focus on space. This key characteristic has an indigenous strength due to its ability to build bridges between various approaches, but also reflects a weakness, in that a uniform or broadly accepted theoretical and methodological framework is lacking.

*'I have never cared for particular disciplines'*
Carlos Adrian

It is remarkable that regional science – in a more narrow sense than the spatial sciences has witnessed a surprisingly rapid pace of growth over the past few decades. Conferences of more than 1000 participants are today no exception. So, in a way, regional science is not only alive and well, but even booming. Its favourable development is supported by a well-functioning institutional framework based on a decentralised and bottom-up constellation (RSAI, supraregional bodies, and a large number of national or language sections), all characterised by a great scholarly commitment.

This model has manifested itself as a rather robust and successful organisational structure. It has laid the foundation for a professional organisation of numerous regional science meetings. Of course, at times there may be a need for change or gradual evolution in structures and bodies, depending on new scientific developments or shifts in the geographical presence of national sections. But such emerging issues can effectively be handled within the existing and well-functioning managerial and institutional mechanisms of the RSAI (including various Councils such as ERSAC, NARSC, PRSCO, WRSA, etc., as well as the RSAI Long Range Planning Committee). In conclusion, the future of regional science looks bright and sustainable. However, a sustainable vital science also needs forward-looking views and perspectives beyond the present horizons, satisfactory as they may be for the time being. This is the focus of the present Manifesto. We now first offer a critical reflection on the ineffectual way in which strategic future research in the spatial sciences is programmed at present.

## 3 Change is Pertinent!

*'Never leave that till tomorrow which you can do today'*
Benjamin Franklin

Our planet is currently facing a wide variety of challenges – both local and global – which – if not effectively addressed – will have far-reaching impacts on human well-being and quality of life in the future. Examples of such megatrends are: rapid population growth in developing countries; ageing in the OECD-part of the world; a worldwide rise in migration flows (voluntary and forced); threatening climate change effects (such as sea-level rise and extreme weather conditions); food and water shortage; increasing spatial disparities; emergence of radical and extremist ideological movements; fears for a loss of security; and so forth.

The spatial projections of such worldwide trends are increasingly visible on our planet. Examples are: the rapid rise of urbanisation; the unprecedented explosion of mobility in many countries; alarming environmental conditions; paralysis in spatial (urban, regional, transportation and environmental) planning, etc. The various threats to – and opportunities for – the spatial quality conditions on our earth are often mentioned, but insufficiently addressed and thought through from a scientific perspective. This is clearly witnessed in the lack of a solid and broadly shared strategic research agenda and related actions taken on the spatial future of our world. The reasons for this regrettable situation are manifold, but are certainly related to weak programming mechanisms on future strategic research in the spatial sciences; which can be summarized as follows:

- The development of the spatial sciences is mainly based on incremental amendment to existing paradigms;
- A major part of research in the spatial sciences follows standard recipes, and is hampered by methodological path dependence, rather than being encouraged to be innovative;
- There is a lack of systematically organised science-dynamics systems which aim to develop forward-looking research strategies based on outside – rather than inside – science perspectives from other disciplines;
- Insufficient innovation in the spatial sciences is also caused by the lack of broadly shared mechanisms for societal demand articulation;
- Unsatisfactory linkage systems prevail in regard to promising developments in other disciplines such as the trend towards data-driven research or data-driven theory development;
- Lack of sufficient integration of different, but complementary disciplinary perspectives (e.g. geography, regional economics, urban economics, political science, urban planning and architecture, transportation science, urban and rural sociology, environmental science, social health science, real estate and cultural heritage management, demography, geo-science, et.) leads to weak policy impacts.

*'Above all, don't fear difficult moments. The best comes from them'*
Rita Levi-Montalcini

All these inadequate elements have been detrimental to a sound and sustainable development of the spatial sciences, including regional science. There is an urgent need for a drastic change in the management of the design process of innovative science dynamics in the spatial sciences, including regional science. Regional scientists may be expected to take the lead in addressing the major future challenges that have far-reaching implications for the spatial future of our earth.

## 4 Challenges Galore

*'Don't limit your challenges; challenge your limits'*
Jerry Dunn

Regional science is characterised by a multidisciplinary orientation. At the same time, there are other related multidisciplinary domains, such as environmental science, transportation science or urban architecture, all dealing with space, and all have their own, professional – often international – organisations. Hence, synergy and symbiosis driven by a jointly shared vision or paradigm is largely lacking. Well thought-out strategies oriented towards 'bonding and bridging', in and between these domains, might create unforeseen opportunities for the spatial sciences. There could be a great potential for regional science to foster in a convincing way intellectual leadership in the broad domain of spatial sciences. Arbitrary examples of challenging issues to be addressed might be: city growth with increasing sustainability; sea-level rise with increasing safety; ageing societies with increasing dynamism; mass migration with increasing societal cohesion; new technologies with increasing human scale, etc.

A vibrant regional science needs to be responsive and creative. However, remaining bright and robust as a scholarly challenge also requires a new scientific spirit that will prompt innovative thinking, now and in the future. Even though national and international regional science conferences and workshops are splendid and necessary vehicles to present and disseminate new knowledge, they are not the proper or exclusive tools for generating attractive seedbed conditions for creative and original ideas which can evolve into new paradigms or radically new ideas for regional science. Our world is full of unprecedented – and other unknown – challenges, which call for an open habitus that is not characterised by 'more of the same'. Such challenges are abundantly present, e.g. climate change, mass migration, ageing, demographic change, new technologies, territorial conflicts, ethnic tensions, mega-city development, etc. All such emerging phenomena call for 'fresh' thinking. The achievement of this unconventional goal would require, as in many other disciplines, a different academic and organisational mode of research in the form of a forward-looking academic 'think tank' of dedicated scientific experts and 'great minds'. In addition, a vital regional science is not only about conducting research, but also about preparing for the next generation of scientists, e.g. through education and training. Since regional science is often a complementary scholarly activity – including regional economics, geography, urban planning, political science, transportation science, land use planning, architecture, environmental science, etc. – it seems pertinent to have – or to build – also strong liaisons with the manifold disciplinary constituencies, not only on the practical side but also on the academic side. And finally, the innovative capacities of the young generation also need to be exploited, as many new ideas do not originate from the learned minds of 'grey-haired' scholars, but from more imaginative and less restricted brains of young scientists.

*'We choose to go to the moon in this decade and do the other things. Not because they are easy, but because they are hard'*
John F. Kennedy

Consequently, there is a need for a new type of learning mode in the spatial sciences, in which a cross-section of older and younger regional scientists takes – and shares – responsibility for the intellectual evolution – or perhaps a radical transformation – of regional science, with a strong emphasis on new theory and concepts, as well as on novel modes of research. Such a smart organisation of 'great minds' by regional scientists cannot be organised in a top-down, hierarchical fashion. It is the free mind that is decisive for the intellectual future of any science, including regional science. What is needed in a complex regional science organisation and constellation is a group of dedicated and committed scholars – preferably with a balanced age, gender, geographical and disciplinary composition – that is able and willing to provide intellectual services with a view to a sound and dynamic future for regional science. This brings us to the idea of a Regional

Science Academy, as a voluntary, decentralised, and scholarly network centre for spatial scientists worldwide. Its objective would be to help contribute to the future vitality of regional science and related disciplines, by offering daring and forward-looking ideas, new forms of cooperation, and new research initiatives.

Thus, the Regional Science Academy is to be a voluntary, bottom-up-driven platform for the generation, identification, promotion and diffusion of new ideas in the spatial sciences. The need for an active and proactive think tank in regional science is even more urgent in the current times, as regional science is more or less reaching a stage of maturity. Maturity – as growth cycle theory purports – calls for innovative actions, especially when there are many policy and research challenges ahead.

In this context, it is noteworthy, that the RSAI has about 4,500 members around the world, organised in 32 sections and 4 supranational associations. This broad field involves more than 30 scientific journals and book series, thus creating and promoting a resilient science through the organisation of many regional science conferences, workshops and congresses, and interconnecting academics, students and experts from many universities and research institutions. The potential to grow is great: if we take into account that the more active RSAI sections in our world have approximately 10 members per 1 million inhabitants, it is plausible to foresee that in the course of time the RSAI may be able to reach about 50,000 members around the world and that through good science and education initiatives it is able to promote sustainable regional development globally. Regional science has the potential to make a difference!

The dynamism of the spatial sciences all over the world has also produced remarkable achievements: Nobel Prizes, NECTAR meetings, ICOMOS workshops, REAL sandwich PhDs and visiting exchanges, ERSA and RSAI summer courses, NARSC workshops, Tinbergen Institute workshops, the diffusion of main Regional Science Schools, and many other initiatives that resulted from the embedded activism of members, sections and supranational bodies. Yet, and at the same time, there is a disturbing and uneasy gap between the theoretical framing of regional science and the practice of regional economic development, as well as between regional science research and regional science education. For example, we have witnessed recent developments towards a 'New Economic Geography' or a 'New Spatial Economics', which address issues related to spatial imbalances in a more emphatic way, from the perspective of the rising importance of 'city-regions' (with many positive and negative externalities) in a dynamic space-economy. Such developments raise intriguing questions on whether the traditional foci of regional science research and education are still relevant.

*'Discovery consists of looking at the same thing as everyone else and thinking something different'*
Albert Szent-Györgyi

An operational idea may be to identify a set of critical issues that fall within the ambit of regional science, and to organise small teams of scholars to develop appropriate multi-task research agendas that, if pursued, might lead to viable solutions. Such experiments might also enhance the credibility of solid regional science research, and lead to its broader acceptance in regional development policy and practice.

It is clear that the future of regional science cannot be left to blind and coincidental forces, but calls for careful thinking. Clearly, a central research coordination (e.g. in the vein of EU FP7 programmes) will be detrimental to creativity and resilience in regional science. This concern ties in with the need for new and future-oriented thinking. An intermediate, flexible and open way of ensuring a vitality and adaptation in regional science research and education is likely the best option, with great promise for a vital future. It would serve the broad field of all spatial sciences, without being subordinate to one of the existing organisational bodies in this field. And, therefore, the idea of a Regional Science Academy may be viewed as a valuable and realistic opportunity and even as an urgent necessity for a vibrant research domain in the spatial sciences. This task will be further outlined in the next section, where some principles of this new organisation will be highlighted.

## 5 The Regional Science Academy: Vision and Mission

*'Vision is the art of seeing the invisible'*
Jonathan Swift

The Regional Science Academy is to be an independent and balanced 'flat' network of recognised, dedicated and active scholars in the spatial sciences, who seek to promote a sustainable future for regional and urban development around the world through scholarly contributions to regional science. This vision is based on advanced regional science theory, research and education, and is envisioned to be achieved through innovative and forward-looking intellectual contributions and initiatives. Its members are committed to share their scientific talents with, and to provide scholarly services to, the regional science community at large on a voluntary basis. This initiative is not born out of criticism of the functioning of existing bodies, but out of the need to support and reinforce the research community in the domain of the spatial sciences. In summary, this ambition can be formulated in the following corporate vision:

**Corporate vision**

The Regional Science Academy is a strategic spatial knowledge catalyst: it acts as a global intellectual powerhouse for new knowledge network initiatives and scholarly views on regions and cities as vital centrepieces of interconnected spatial systems.

The added value of the Regional Science Academy can be highlighted by focusing on the realisation of the following overarching aims related to its long-term corporate vision, which is to:

- Enhance the critical role of regions and cities worldwide as vital, livable and sustainable places with a high quality environment for living and working;
- Develop the foundations for an integrated regional theory and methodology, perhaps by starting to reflect on the background and foundations of regional science;
- Design socio-economic, ecological and planning ground-level research that is policy-oriented and innovation-driven;
- Provide the scholarly and policy tools for developing, assessing, and aiding the effective implementation of research, with a view to tackling future challenges for regions and cities all over the world, based on a merger of serendipity-driven and client-oriented research.
- Develop communication mechanisms for sharing the knowledge base in the regional science field, in particular by addressing novel and path-breaking perspectives on regional science research.
- Nurture the future of spatial analysis by addressing forward-looking models (e.g. models of change and shocks) and plans ('Burnham-style operations').
- Act as an intellectual platform for exchanging creative knowledge on spatial (regional, urban, geographical or transportation) development, in cooperation with a younger generation and with scholars from emerging and developing countries.
- Design original and practical regional science curricula descriptions that ensure a high quality, form the basis for accreditation, and shape a new generation of young regional scientists.

*'We need to understand what we can do and how. Otherwise we will never do it'*
Constantinos Apostolou Doxiadis

Clearly, some realism is needed as well. All such high ambitions cannot be realised at the same time. A step-by-step and balanced priority strategy will be needed to ensure steady progress and to avoid disappointment. Dedicated individual efforts – organised at a collective level – will be needed to implement priorities and to support the unfettered rise of new ideas, concepts and methods. Consequently, a careful programming – including prioritisation – of voluntary activities in the spatial sciences would need to be based on a commonly shared, professional business plan, driven by a mission statement. What is then the mission of a Regional Science Academy?

**Mission statement**

The Regional Science Academy is a service-oriented scholarly network for rethinking and managing the spatial dynamics of people and socio-economic activities in connected and complex spatial systems of our earth by:

- developing new interdisciplinary knowledge and knowledge initiatives for strengthening regions and cities as liveable, vital and resilient places;
- creating and exploiting scientific synergy – and related smart governance action – on regional and urban development, from an economic, social, demographic, policy, cultural, logistic, mobility and innovation perspective, at different spatial scale levels.

The Regional Science Academy aims, therefore, to generate original (sometimes radical) and creative ideas, concepts and initiatives that benefit regional scientists and society all over the world, in particular, through the execution of the following action plans:

- To act as a catalyst for the genesis of novel and original future-oriented cornerstones for a vital regional science including, in particular, novel conceptualisations, new theoretical paradigms, innovative methodologies, unconventional application fields, or proactive and smart governance mechanisms;
- To favour the dissemination of the body of regional science knowledge towards various interest groups, such as scholars from related and sometimes distant disciplines, policymakers and planners, or the business community, so as to provide novel liaison services for effective solution-oriented contributions to sustainable regional and urban development; the regional science community should be able to develop a new habitus or collective ethos, where 'solutions on demand' might be created;
- To map out, synthesise and monitor a wide array of educational, teaching and training programmes in regional science in different educational institutions or places worldwide, at the Bachelor, graduate/postgraduate/research Master level, with the aim to form a clearing house for advanced regional science education, which may provide guidelines for the development of curricula in regional science and related disciplines (e.g. textbooks used, recognition and certification of programmes, sandwich PhDs, twinning programmes, summer courses, etc.);
- To ensure a permanently vital development of regional science through the active involvement of young promising regional science scholars – for instance, through a Young Chamber of the Regional Science Academy (with a relatively independent constituency) – so that the 'next gen' can act as a source of new research ideas, or for shifting boundaries (e.g. happiness research, social justice, ageing, sustainable spatial development, e-research, human health, global logistics, global urbanisation, resource ownership, safety research, forced migration, etc.).

The Regional Science Academy will have, by its very nature, an inclusive stature that is different from the RSAI Fellows system. The latter class is an exclusive and respected group of talented and recognised scholars in regional science who received their honorary position on the basis of their past performance (i.e. high-quality contributions to regional science research); it is a honorary position without any further direct commitment. The Regional Science Academy is much more a voluntary intellectual workhorse with the dedicated aim to provide to the worldwide community of regional scientists a wealth of academic services that are forward-looking and strategic in nature, so as to ensure a sustainable vitality of regional science research in a broad and advanced global research and knowledge arena. Its role is purely supportive and complementary to the existing activities of the RSAI and its related bodies; by no means should it be competitive with existing initiatives. It is inclusive, with the aim to connect the multifaceted world of the spatial sciences through scholarly network initiatives, originating from the 'free mind' of spatial scientists all over the world.

*'If I have seen further than others, it is by standing upon the shoulders of giants'*
Isaac Newton

It is thus foreseeable and realistic that the Regional Science Academy will be an independent institution for complementary strategic and intellectual service provision for the spatial sciences, with close links to the regional science community. At its meeting on 27 Augustus 2015 (Lisbon), the RSAI Council generously offered to support the Regional Science Academy, under the aegis of the RSAI. Clearly, it will function as a broad umbrella institution for all fields in the spatial sciences.

## 6 Organisation

*'Make men work together; show them that beyond their differences and geographical boundaries there lies a common interest'*
Jean Monnet

The formal roles and tasks of the Regional Science Academy and its members, as well as its institutional structure, are to be described in its Constitution and its By-laws, which will have to be the first priority in the Academy's work plan. This section only offers some first consensual ideas on the ways to proceed.

### *6.1 Membership*

The Regional Science Academy is not institutionally oriented, but based on the renowned expertise of dedicated individuals with expertise in the spatial sciences. The founding members of the Regional Science Academy should agree on the rules and guidelines of membership, and should feel committed to it. Membership should be based on commitment to the goals of the Academy and to its ambitious scientific contributions and qualifications. Consequently, the Regional Science Academy comprises spatial scientists who:

- Have a proven record as a dedicated and recognised leading scholars in regional science;
- Are explicitly committed to help implement the basic goals of the Academy;
- Are expected to play an active role in the pursuit of regional science initiatives, in particular:
  - through participation in forward-looking 'think tank' and 'great mind' activities;
  - through the organisation (including sponsorship) of road map workshops or advanced brainstorm carrefours (ABCs) for encouraging innovative regional science research perspectives;

- to assist in teaching and supporting 'out-reach' activities in regional science curricula worldwide;
- to offer stimuli to young regional science researchers by inviting them for a 'refreshment stay' or to participate in collaborative work (e.g. through a pairing system).

It seems plausible that the total membership in number may range from 70 to 150 in a fully mature stage. After the founding stage, a system of application, admission, and selection needs to be developed and put in clear terms in the Statutes (see later). It seems plausible to assume that any recognised regional scientist who offers a concrete promising activity in accordance with the goals of the Regional Science Academy qualifies, in principle, to be a member. It may also be wise and useful to think of a rotational system where membership of the Regional Science Academy might be restricted to a term of 5 years (perhaps, with a prolongation of one more term). Such membership issues have to be further formulated in the Constitution and its By-laws.

*'There is no more powerful engine driving an organization toward excellence and long-range success than an attractive, worthwhile, achievable vision for the future, widely shared'*
Burt Nanus

### *6.2 Activities agenda*

The Regional Science Academy would have to avoid overlapping activities with other RSAI activities or activities from related institutional bodies (e.g. NECTAR). It ought to provide complementary services to existing RSAI members and members of other bodies in the spatial sciences. Examples of such an operational and executive agenda could be:

- Programmes to create new innovative ideas or concepts in the spatial sciences; the need for a solid theoretical foundation of regional science ('regional theory') is pertinent;
- Programmes to raise regional science questions of an intellectual nature that are as yet not being addressed and to present these to international fora;
- Programmes that are motivational for young and promising scholars in the field (e.g. those belonging to a Young Chamber of the Academy – see the next point);
- 'Next gen' initiatives for students: they will not only be targets of training/education, but the Academy will also create agendas for and with them, e.g. through the vehicle of a Young Chamber of the Academy (to be decided at a later stage);
- Encouragement for new forms and/or types of intellectual leadership in regional science (with a particular view to non-conventional thinking);
- Involvement of leading scholars from fields other than regional science (given that it is interdisciplinary and not a single discipline), including – but not limited to – traditional affiliated fields such as geography, transportation, logistics, planning, administrative science, economics, visual and performing arts, business, law and the environmental sciences. Other fields that are likely to offer new concepts and theories that could be adapted to investigate and model regional science issues and problems of a spatial nature may include archaeology, history, physics, chemistry, biology, bio- and medical science, sociology, psychology, architecture, engineering;
- Development of web-based open platforms to share new research, teaching resources or curricula, which can be replenished on a voluntary basis and freely accessed by all ('open regional science').

*6.3 Administrative aspects*

- The Regional Science Academy is an interactive social network of scholars that should have the lightest network structure possible. It may be administratively managed by a recognised and experienced regional science scholar with a sufficient institutional backing. Of course, there should be a Board (chaired by a President, and perhaps supported by two Vice-Presidents, and perhaps some additional five to eight more members overseeing and coordinating all operations). Other aspects to be considered in the Statutes are, inter alia: a kind of efficient administrative infrastructure to provide planning, project support and sustained effort;

- A funding mechanism for start-up activities, as well as for sustained efforts. A focus on innovation processes and outcomes might be a way to create a funding mechanism, e.g. on the basis of a working group whose members have entrepreneurial experience;

- Marketing/public relations as a dissemination tool, for both the scientific community and the users at large;

- A communication infrastructure – newsletters, periodic news releases, white papers (perhaps with stamps of approval), etc.

*'If you can dream it, you can do it'*
Walt Disney

Clearly, the Statutes and the working rules will be instrumental in implementing the action strategy sketched above. We will now address some first initial actions.

## 7 Modus Operandi

*'Regions of the world, unite! You have nothing to lose but your borders'*
Güney Celbiş

The various preparatory brainstorming sessions held in various places – Rabat, Amsterdam, Poznan, Lisbon, Portland – offered ample time and opportunity to discuss in greater detail the operational steps originating from the corporate vision and mission statement of the Regional Science Academy. Using the path-breaking Doxiadis' cruise experiment (1963) as a role model – which led to the influential and seminal Delos Declaration in 1963 – in the various preparations both strategic headlines and operational tasks and pathways were discussed in a consensual way, taking into consideration the necessity to establish a Regional Science Academy which is both attractive and viable. In this way, the foundation stones for a promising initiative could be laid in the interests of the regional science community at large, so that the Regional Science Academy can serve as a signpost for future regional science activities which really matter and make a difference.

*'The empires of the future are empires of the mind'*
Winston Churchill

Both strategic and operational tasks and issues have been addressed in the preparatory meetings, but they need of course more elaboration and focus. From a practical perspective on the identification of concrete action plans described in the next section, a systematic scanning and scoping approach turned out to be helpful. The following schema (Figure 1) was, and may be, instrumental in structuring the emerging ideas on the viability and future orientation of a Regional Science Academy. It aims to offer a coherent design map for future activities. It is clear that the formulation of a road map for the Regional Science Academy is a matter of joint interaction among its members and its clients, and needs to be reiterated at regular time intervals.

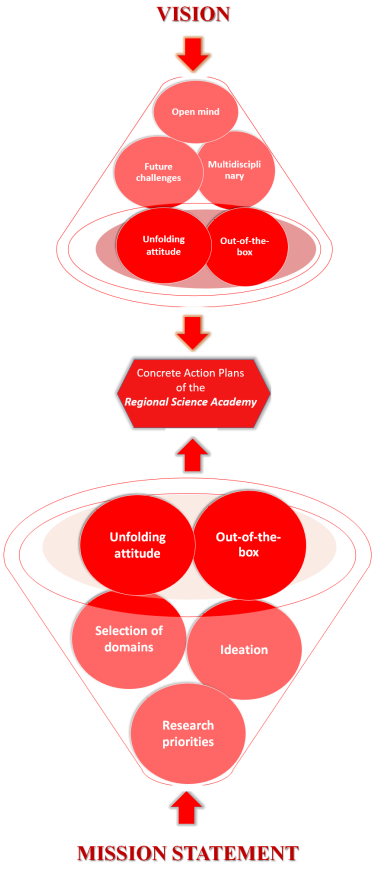


Figure 1: Regional Science Academy Action plans

## 8 Concrete Action Plans

*'Vision without action is a daydream. Action with without vision is a nightmare'*
Japanese Proverb

The idea of a Regional Science Academy has spurred a wealth of new plans and actions by various enthusiastic participants that can meaningfully be taken on board and put in operation by motivated members. From the great variety of proposals and enthusiastic ideas, we have composed four long-term activity fields, from which a diversity of concrete actions plans can be derived in the form of four work packages for these key actions[1]. These activity fields are shown in Figure 2.

It goes without saying that these four activity fields represent four interconnected perspectives of the Regional Science Academy. These four activity fields will be described in slightly greater detail in the remaining part of this section. Next, we make a number of suggestions on how to put these concrete tasks in action.

*'You've got to think about big things while you're doing small things, so that all the small things go in the right' direction'*
Alvin Toffler

[1]Part of this workplan was inspired by a noteworthy and ambitious perspective on the future of regional science, developed by Antoine S. Bailly and Lay J. Gibson on: Securing the Future of Regional Science as a Core Discipline, Studies in Regional Science, vol. 45 (2), 2015, pp. 119-125.

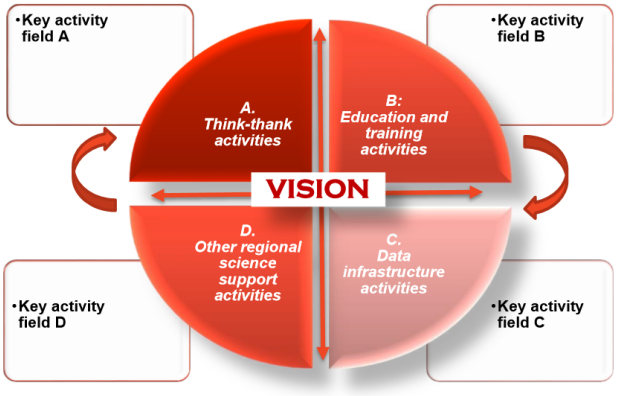


Figure 2: Regional Science Academy Action plans

### *8.1 Think-tank activities*

Think-tank activities refer to forward-looking and pro-active scholarly reflections on the foundations of and future directions for regional science, be they theoretical, methodological or policy-oriented. As a first trial, various tentative ideas were already derived from a so-called 'brain-shaker' experiment[2]. Examples of issues to be addressed are:

- What are the prolegomena and foundations of spatial theory?
- Is the role of space in regional science a passive or an active one?
- How does space play a role (opportunity-creating or friction-creating) in a multidisciplinary orientation of regional science?
- Is there a need for designing a 'science for cities' and if so, how?
- Which megatrends in the spatial sciences can be identified that have a direct bearing on future research and policy challenges (using, for example, scenario or imagineering techniques), and how can knowledge gaps be filled from foresight experiments?
- Which are the critical grand challenges for our global space-economy which have profound urban and regional implications in the future (e,g. a post-urban society)?
- What are the long-term consequences of the continued urbanisation and the dissolution of the traditional urban-rural dichotomy? Are we moving towards a post-urban world?
- How do new findings from other disciplines (e.g., behavioural economics, experimental psychology, evolutionary sociology, network analysis, business management) impact the future of regional science?
- Has regional science a relevance for global debates on international trade, foreign migration, economic recession, emerging economies, human health, international peace, climate change policy, and the like?

A careful scoping of all such open future issues on the principles of regional science, its broader societal relevance, and its contribution to policy and smart governance would be needed. Such a systematic scoping experiment may lay the foundations for a catalytic and progressive development in auto-revitalising regional science theory, methodology and policy with a view to the future.

[2]This was a thought experiment among founding members to distil some first meaningful further ideas; see also K. Kourtit, T. Dentinho, P. Nijkamp and V. Royuela Mora, Envisioning Experiments on the Future of Regional Science. In: Regional Research Frontiers (R. Jackson and Schaeffer, P. eds.), Berlin: Springer-Verlag (forthcoming).

*8.2 Education and training activities*

Regional science needs a solid cognitive underpinning of the human capital embodied in its scholars. In many cases, regional scientists borrow their intellectual toolboxes from other disciplines, such as economics, geography, transportation science, architecture, and political science. There is no such thing as a 'standard' regional scientist. For the sake of visibility, recognition, job profiling, and the future strength of regional science, serious attention might be given to the educational and training aspects of regional science. For example, what may we expect from a Master course on location theory or geographic information systems or, even more ambitiously, regional theory[3]? The issue of a Regional Science curriculum would certainly need a special interest group with a broad composition.

It would be highly desirable to create a portfolio of requirements or desiderata for either individual curricula (both Bachelor and post-graduate, both minor and major) which may be seen as cornerstones of a regional science education programme. Designing such a road map could be initiated with an inventory of different educational and training programmes worldwide. This might then lead to a consensual discussion on expectations regarding relevant courses, including teaching materials, textbooks, etc. This would strengthen and highlight the essence of regional science as a scientific mode.

A second strand in the category of Education and Training Activities would be the design of new themes and the organisation of intensive pedagogical Summer Institutes and the like on dedicated novel themes in regional science, where the ingredients of such an experimental course might be somewhat standardised so as to comply with international standards for scientific curricula. It may also be possible to develop digitally available curricula, e.g. as video or televideo presentations. Here, we may build on existing and new initiatives, so as to avoid overlap.

Another issue which deserves profound attention is the issue of the recognition and certification of Master's Degrees based on the content analysis of their courses (interdisciplinary regional diagnosis, regional and urban economics, spatial econometrics, regional and urban modelling, geo-science information, and policy design and evaluation). This may be related to a discussion and appraisal of papers presented by Master's students in regional science sections or supranational and world meetings.

One might also envisage the publication of free online textbooks, with the support of the various RSAI sections, translated into the main languages (English, French, Chinese, Japanese, Russian, Spanish, Portuguese, Arabic, ...), on interdisciplinary regional diagnosis, regional and urban economics, spatial econometrics, regional and urban modelling, or policy design and evaluation, and the like.

*'There's a way to do it better, find it'*
Thomas Edison

Another related idea is to offer students the opportunity to receive a Certificate in Regional Science, whose requirements would be approved by the Regional Science Academy. To attain the certificate, the students concerned would have to complete a prescribed number of courses – perhaps 5 or 6 (including e-courses). These courses would cover the foundations of regional science in the areas of theory, methods, and practice/application. Each of these could be a track within a given curriculum. There is a number of ways in which the curriculum could be structured, e.g. with one option requiring students to take two courses in each of the aforementioned tracks. These courses would be chosen from a catalogue of approved courses. The courses in the catalogue would originate from universities across the world. This would provide students with the opportunity to take courses from prominent regional scientists from various universities around the world. Or they could take all courses from one university if enough were offered. The option to take courses from multiple institutions would allow students where regional science is less prominent to complete the certificate. For example, at the University of Toledo one might only have one or two courses that would qualify as certified courses in

[3]For an example the description of a Graduate Programme in Regional Science at Cornell University, see http://www.aap.cornell.edu/crp/programs/regsci/index.cfm.

the catalogue. Thus, a student there could take these one or two courses and then enrol in courses at another institution (on site and/or on line) to complete the Certificate.

Clearly, to achieve these goals it will be necessary to establish a set of nodes in a world-wide educational network that can offer hosting, training, and research opportunities. This also calls for prominent committed teachers who would help establish the Academy, nurture its future development and champion new initiatives worldwide.

*'Without the playing with fantasy no creative work has ever yet come to birth. The debt we owe to the play of imagination is incalculable'*
Carl Jung

There are of course logistical barriers to this idea – e.g. students paying for travel, housing, and tuition costs at other institutions, etc. There would need to be a Curriculum Committee of sorts to oversee the Certificate – both to approve new courses that want to be added to the catalogue, and to certify that a student has completed the requirements for the Certificate. Perhaps, a graduation ceremony could be organised at the ERSA and NARSC, AMERICAS or PRSCO meetings where students are presented with certificates. In this line of thinking, there is already a tentative list of Regional Science Schools[4] where the education of regional science is taking place.

Training younger researchers with an international accredited programme will improve the social value added and the academic recognition of the field, while in the long term it may lead to an increase of resources for education and research; this should improve the amount of resources to fund the education of people from/in developing countries.

Clearly, there are many opportunities for educational cooperation among different institutions, through training programmes, sandwich programmes, and the like. Thus there is much scope for organised educational regional science initiatives, based on a distributed network structure.

*'To raise new questions, new possibilities, to regard old problems from a new angle, requires creative imagination and marks real advance in science'*
Albert Einstein

### *8.3 Data infrastructure activities*

The development of many sciences today is centred on large information systems and data warehousing platforms (e.g. in physics, biology, climatology, bio-medical sciences, etc.). It seems promising for the future of regional science to shift from the analysis of ad hoc databases to more structured and coherent databases, to be shared with many spatial scientists world-wide. Both open-access standardised data collection and sharing are critical for collective progress in a given field of scientific research. This would enhance international cooperation and joint agenda setting. Such a plan would call for an ambitious initiative. The Regional Science Academy might act as a catalyst to design the principles of such an international cooperation initiative, to define standards, and to specify the organisational modalities. In many sciences nowadays, data infrastructures are nowadays the integrating and connecting mechanism for novel theory development and original research initiatives (e.g. in the area of physics, through CERN). It is foreseeable, that 'large spatial data' and 'data-driven theory' will become one of the new pathways in future regional science research. An exploration of such an untapped potential for regional science might be promising and might also help to pave the roadway forwards to more harmonised replication studies. Later on, the actual execution and implementation of research may be handed over to other professional bodies (e.g. RSAI).

*'Science knows no country, because knowledge belongs to humanity, and is the torch which illuminates the world. Science is the highest personification of the nation because that nation will remain the first which carries the furthest the works of thought and intelligence'*
Louis Pasteur

[4] http://www.regionalscience.org/index.php?option=com_k2&view=itemlist&layout=category&task=category&id=156&Itemid=735

### *8.4 Other regional science support activities*

The regional science field is vast. The activities of the Regional Science Academy should in particular address issues that set the agenda, and less its actual execution. The implementation step can be handed over to the field of existing organisations. This also ensures harmonious cooperation based on symbiosis. The development of regional science depends on many initiatives to be taken on a voluntary basis by individual scholars. In addition to the above-mentioned action lines, one might think of other initiatives such as:

- The strategies for better knowledge dissemination (e.g. e-platforms);
- The inclusion of regional science as one of the descriptors in the OECD database[5]
- The development of transformative ideas (e.g. scenarios) on the new spatial structure of our planet;
- The enhancement of liaisons with international bodies (World Bank, UN, OECD, EU, NGOs, etc.);
- The formulation of a 'code of conduct' for regional science research;
- The systematic fund raising from donors;
- The marketing of regional science in a global knowledge society, etc. through externally-oriented websites.

*'Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less'*
Marie Skłodowska-Curie

Many more activities could be envisaged, but the choice and implementation of such plans depends on the efforts and creativity of the members of the Regional Science Academy. In the course of time, several new ideas may come up and be put into practice. There is clearly a need for a 'rolling agenda'! Consequently, the design of a commonly shared road map for the Regional Science Academy should have a high priority.

## 9 Epilogue

*'Learn from yesterday, live for today, hope for tomorrow. The important thing is to not stop questioning'*
Albert Einstein

This Manifesto is provisional in nature, and hence is being subjected to the critical remarks of the worldwide regional science community and of spatial scientists in a more general context. The Regional Science Academy is work in progress. The basic premise of the Regional Science Academy is its goal to be instrumental in designing forward-looking initiatives (the 'Prometheus model') in order to ensure a vital and sustainable regional science field. Its added value would have to be more than merely offering a supplement to the prevailing strong research tradition that is often focussed on incremental amendments of past findings (the 'Epimetheus model'). Regional science is too precious to be left exclusively in the hands of traditional academic research, despite its great merits. Strategic planning on ways forward is a sine qua non for a permanent rejuvenation. This is a joint responsibility of the community of spatial scientists. The mobilisation of 'great minds' is a basic task for any vital science. Science innovation is a task that has a great meaning for the future of regional science, and home for the future of regional and urban development.

*'The best way to think about reality, I had decided, was to get as far away from it as possible'*
Haruki Murakami

[5] See website: http://ipscience-help.thomsonreuters.com/incitesLive/globalComparisonsGroup/globalComparisons/subjAreaSchemesGroup/oecd.html