Economic Geography within and between European Nations: The Relevance of Density, Urbanization and Market Potential

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Abstract

The uneven spatial distribution of economic activity is a well-established stylized fact. Some regions or countries are able to attract the bulk of economic activity while others lag behind. Both economists and geographers seek to explain why this might be the case. Although the literature is huge, two views dominate the recent research in economics: urban economics and the new economic geography (NEG). A main difference between the two approaches is that urban economics neglects spatial interdependencies between regions whereas NEG stresses the relevance of the relative location of a region. In this paper we estimate simple versions of these two different views on economic geography. In doing so, we also try to establish if the relevance of spatial linkages varies across aggregation levels and across time. For our sample of European countries and regions, we find that in general foreign market potential is more important on the country level of aggregation, than on the region level. On the latter level of aggregation, urbanization seems more important.

JEL Code: F12, F13, R11, R15

1 *Introduction*

In urban economics, cities or regions are assumed to be like freely floating islands (Fujita and Mori, 2005) since spatial or "inter-city" interdependencies are typically not taken into account.[1] In NEG, however, the *inter*regional interdependencies are at the heart of the analysis and this sets NEG apart from urban economics. This difference as to the depiction of economic geography provides an opportunity to analyse the relevance of these two views. In the end, this is an empirical question (Combes, Duranton and Overman, 2005). If the attractiveness of a country, region or city is best described by intraregional characteristics, this is evidence in favour of urban economics. If in contrast the interregional linkages are relevant this provides evidence in favour of NEG. Furthermore, the relevance of the two theories could depend on the level of aggregation and/or vary over time. It is claimed that NEG is more likely to be relevant on more aggregated levels of measurements (nations). Data on different aggregation levels could reveal whether or not the explanatory power of the two approaches depend on the spatial aggregation level. In this paper we start to address these issues: the relevance of location, the influence of aggregation levels and the time period under consideration. In doing so, we take the basic message of Leamer and Levinsohn (1995, p.1341) "estimate don't test" seriously. We will show the usefulness of both theories, and in doing so restrict ourselves to the estimation part. We also take their second message seriously "don't treat theory too casually", and explain how our two basic estimates can be grounded upon theory.

In section 2 we explain the difference between urban economics and NEG in somewhat more detail and focus on the depiction of economic geography. In section 3 we introduce the basic equations we try to estimate and indicate how they might be derived from theory. In section 4 we describe the data-set and present some descriptive statistics. Section 5 presents the main estimation results. We find, in general, that geography or market potential is more important on the country level of aggregation than on the regional level. Section 6 concludes and also points out some limitations of the present analysis.

[1] See for instance the special issue of the *Federal Reserve Bank of New York* on urban dynamics in New York City (2005) that offers detailed information on urban aspects of New York at an impressively small scale.

2 *Economic Geography in NEG and Urban Economics*

In their excellent survey of the theory of agglomeration, Ottaviano and Thisse (2004, p.2576) ask the question "where did we stand in 1990?" which is to say prior to the publication of the first new economic geography model by Krugman (1991). They observe that all the important elements were already present in the existing location theories in mainstream economics, but not incorporated into a single consistent framework which was provided by Krugman (1991). Krugman (1991) added the element of interregional factor (labor) mobility to an existing trade model (Krugman, 1980). The 1980 trade model already incorporated (internal) increasing returns to scale and transport costs that together constitute the fundamental trade-off in spatial economics (Fujita and Thisse, 2002). The incorporation of transportation costs is responsible for the home market effect that says that both firms and workers are better off in the larger region because firms can benefit from the larger market size and consumers do not have to pay transport costs. Most importantly in Krugman (1991), where the home market effect is combined with factor mobility, this can result in core-periphery patterns in a general equilibrium framework with imperfect competition.

Krugman (1991) and the subsequent NEG models can thus be seen as belonging to a much more extensive (and older) literature in regional economics or even economic geography at large where spatial interdependencies are at the heart of the analysis. In this literature on multi-regional systems, the economic performance of firms or workers in a region is a function of the (relative) position of this region *vis a vis* other regions across the economic landscape. The performance of your region depends on the developments in and characteristics of neighboring regions: regions are therefore *not*, in the words of Fujita and Mori (2005, p. 395), like "freely floating islands". Note that the concept of "region" is not clearly defined; it could refer to a city, a region as well as to a country.[2] What we want to emphasize in this paper is that spatial interdependencies *between* locations are key to NEG in the sense that the spatial allocation of economic activity across space is central in the analysis.

[2] See for surveys of NEG, Baldwin et al. (2003), Combes et al. (2008), Brakman, Garretsen and Van Marrewijk (2009).

This non-trivial role of the spatial distribution of economic activity amounts to saying that economic geography matters in NEG. For our purposes it is important to distinguish between the short and the long-run. In the long run, when the spatial allocation is endogenous, economic geography is the outcome of the model. In the short run, however, the spatial distribution of economic activity is given. The prediction of NEG models in the short run is that *inter alia* factor prices (wages) are higher in regions with a large (real) market potential. In a large market, with a large home market, the demand for factors of production is also large and this raises factor rewards. In the short run, economic geography is a therewith a determinant of factor prices.[3] A testable NEG hypothesis is therefore if a spatial wage structure can be confirmed by the data. In the next (sub-) section, we will use the NEG wage equation to make this more explicit. Note, finally that to the extent that economic geography plays a role in NEG, it is the *inter*regional interdependencies that matter.

A rather different view on the role of economic geography is offered by urban economics. In urban economics, spatial or "inter-city" interdependencies are not taken into account.[4] Transport costs or more generally distances between locations are not included in the analysis. Instead, the emphasis is very much on (external) scale economies (both positive and negative) at the local/city level that should explain why cities exist and also why cities vary in size and in the scope of their activities. Apart from the well-known Marshallian sources of positive economies of scale at the urban level (knowledge sharing, labor market pooling, input sharing), there is a whole range of sources of agglomeration or scale economies that is called upon to explain the existence of cities and their variation in size (Rosenthal and Strange, 2004; Overman, Rice and Venables, 2008).[5] Compared to NEG, urban economics offers a more

[3] A large market will attract firms and workers to the increasing returns sector; if labor supply from the constant returns sector is upward sloping (concave production function) economy wide increases of factor rewards are possible (see Head and Mayer, 2004 for a discussion).

[4] Note, that this does not imply that regions do not sell or buy from other regions, only that costs or income are not dependent on the specific location of an 'island'.

[5] Duranton and Puga (2004) focus on *mechanisms*, rather than sources. They note (p. 2066): "consider, for instance, a model in which agglomeration facilitates the matching between firms and inputs. These inputs may be labeled workers, intermediates, or ideas. Depending on the label chosen, a matching model of urban agglomeration economies could be presented as a formalization as either one of Marshall's three basic *sources* of agglomeration economies even though it captures a single *mechanism*." They identify three basic mechanisms: sharing, matching, and learning. Sharing refers to indivisibilities (e.g. an opera-house is only economically feasible in large cities; sharing costs). Matching refers to the quality of a match between worker and employer in labor market models (large

detailed analysis of location (city) specific agglomeration economies, and this holds not only for positive but for negative agglomeration (congestion) economies as well (see for an extensive survey Rosenthal and Strange, 2004).

As to the role of economic geography in urban economics, the *spatial equilibrium condition* that is central to modern urban economies (Glaeser, 2008) stipulates that agents must be optimally choosing their location such that (in equilibrium) they are indifferent between locations. This implies that in equilibrium the balance between agglomeration benefits and costs are equal across locations. But what matters for our present purposes is that these locations are spatially not connected. When the spatial equilibrium condition is combined with local or city-specific agglomeration economies, a complete (and testable) model of urban economics takes shape. But when explaining (the growth of) city size, the focus is still (exclusively) on city-specific variables like a city's human capital, local (dis-) amenities or the city's economic structure (Moretti, 2004, Berry and Glaeser 2005, Glaeser, 2008).

Economic geography in the sense of spatial interdependencies *between* cities is at best implicitly taken into account, like in Henderson's seminal model of urban systems (Henderson, 1974). In this model, and depending on the industry specific differences in local external increasing returns, cities specialize in certain activities and trade with each other, but intercity distances do not matter and non-urban areas play no role at all (Glaeser, 2008, ch. 3 , Combes, Duranton and Overman, 2005). If at all, economic geography is only relevant in the shape of the *intraregional* spatial distribution of city's economic mass or of its population. Higher levels of density are associated with larger and more productive regions and cities. The idea here is that increased density signals a larger local demand, cheaper intermediate goods and/or stronger agglomeration economies of the Marshallian type mentioned above. In empirical applications (see notably Ciccone and Hall, 1996 and Ciccone, 2002), population density or employment density is therefore used to explain interregional differences in income (wages) or productivity. In the next section, we will use a wage equation to make the connection between urban economics and density more explicit. In doing so, it will also become clear that the key difference between NEG and urban economics

cities offer a higher probability of a successful match). Learning refers to the need for face-to-face contact (in large cities with more contacts the quality of learning is higher).

as to the role of economic geography is whether or not neighboring areas or locations matter (Combes, Mayer and Thisse, 2008, p. 290).

Despite this different view on economic geography, there is considerable overlap between the basic NEG and urban economics models. This not only holds for the (micro-economic) analytical foundations but even to some extent for the alleged relevance of economic geography. In NEG models, economic geography can be decomposed into the economic geography of the home or own region and the economic geography of the relationship between the own region and the other regions. The former basically tries to capture the same within-region effects as the models that include regional density, the real difference is therefore in the latter, see also wage equations (1) and (3) in the next section.

In their comparison of the Henderson (1974) urban economics model and the Krugman (1991) NEG model, Combes, Duranton and Overman (2005) not only conclude that there is no inherent contradiction between the urban systems model, but that the important empirical question is which model is applicable in which situation.[6] They argue that NEG is probably more relevant at a *larger spatial scale* where spatial interdependencies between locations are most important and the within-location agglomeration and dispersing forces are of secondary importance. In contrast, the urban economics approach is thought to be more relevant at smaller spatial scales (regions or cities), where local (positive and negative) externalities are most important and between-city interactions and long distance relations are less important: "we would argue that there is no inherent contradiction between the urban system approach and NEG: the latter is trying to explain broad trends at large spatial scales while the former attempts to explain "spikes" of economic activity" (Combes, Duranton and Overman, 2005, p.330). If this is correct one might conclude that distance decay effects are stronger on the regional as compared to the international level (compare for instance Redding and Venables, 2004 with Hanson, 2005) but these differences may also be due to differences in the trade costs specification used (Head and Mayer, 2004; Bosker and Garretsen, 2008a). In any case most NEG studies do include density measures only as an (optional) control variable (Breinlich, 2006).

[6] See for a similar conclusion Combes et al (2006) and Overman, Rice and Venables (2008).

Empirical studies that focus on density on the other hand, typically do so by allowing only the own region's density to play a role (see Ciccone, 2002 for an exception and see also Duranton and Overman 2005 for the spatial reach of productivity spillovers).

Empirical studies that systematically try to assess the relative importance of density (urban economics) *vs* market potential (NEG) are scarce. Fingleton (2005, 2007) is an exception but he focuses on one spatial scale (UK regions in Fingleton 2007; the EU regions in Fingleton, 2005) and does for a relative short time span. In the present paper, we first of all of focus on 2 spatial scales (14 European countries and, from 1975 onwards, the corresponding NUTSII regions). One of the criticisms levied against NEG from, for instance "proper" economic geography (Martin, 1999, 2008), is that NEG models are scale invariant. We want to establish if the relative strength of intraregional and interregional economic geography is different on the European country level than on the regional level. Are the spatial interdependencies emphasized by NEG indeed more relevant at the national level?

Apart from the possibility that the kind of economic geography that matters is scale-dependent, we also want to find out if the strength of within and between region economic geography varies over time. Many of the empirical studies in urban economics or NEG (mainly) take a cross-section perspective, whereas (see also the next section), spatial linkages may vary over time. One could for instance stipulate that spatial interdependencies between countries (or regions) become more important during periods of economic and political integration.

Based on the general discussion in this section, how do we proceed from here? In the next section, we will show how our two main explanatory variables, density (urbanization) on the one hand and market potential on the other hand; follow from basic urban economics and NEG theory. Armed with this theoretical foundation, we will then introduce our data set and estimation strategy and present the main estimation results.

3 The wage equation and the use of density and market potential

In the previous section we explained that regional differences can be explained using two different approaches urban economics and NEG. The aim of this section is to outline how our main specifications in the estimations can be traced back to structural models. We start with the urban economics approach first, and then concentrate on NEG.

A simple model that already provides a remarkable rich variety of forces is conveniently summarized by Combes, Mayer and Thisse (2008, ch 11). Assuming a firm with a Cobb-Douglas production function that uses labor and a (composite) of other inputs, that has all other markets as destination markets and maximizes profits, can pay the following wage[7]:

(1) $$w_r = \frac{\mu(1-\mu)^{(1-\mu)/\mu}}{n_r} \sum_{j \in (r)} s_j \left(\frac{p_j A_j}{r_j^{1-\mu}}\right)^{1/\mu}$$, where w_r = wage in region r; μ = share of labor in the production process; n_r = the number of firms in r; s_j = labor productivity variable; p_j = price of good j; A_j = technology (Hicks-Neutral); r_j = price of (composite of) other inputs.

Equation (1) shows that wages in region r can be high because the efficiency of labor, s_j, is high or the level of technology, A_j, in this region is high. The latter term might reflect region specific, Marshallian externalities, for example knowledge spill-overs between firms or labor pooling, in region r. Also, an increased supply of intermediate production factors that result in lower intermediate product prices, r_j, allows for higher wages. Furthermore, more (or less) competition, that is a higher (lower) n_r and lower (higher) p_j, result in lower (higher) wages. Firms in region r also sell their products to other regions, but the location of region r relative to other regions is not an issue. So, despite being relative simple, equation (1) already captures a menu of spreading and agglomeration forces that characterizes a region. For this paper it is important to note that all variables in equation (1) reflect characteristics of the region itself and not that of surrounding regions.

For empirical research the main question is how to estimate equation (1). A straightforward procedure is as follows. Taking logs of equation (1) gives:

[7] See appendix for the derivation of equation (1)

(2) $\ln w_r = \alpha_1 + \alpha_2 \ln Dens_r + \varepsilon_r$,

Where $\ln Dens_r = \ln \frac{1}{n_r} \sum_{j\in(r)} s_j (\frac{p_j A_j}{r_j^{1-\mu}})^{1/\mu}$, and where $Dens_r$ stands for the employment or population density in region r.

Apart from the potential impact of density, there are other variables that one wants to include as well when estimating (provided the available data allow one to do so). In a panel setting, the inclusion of region (city) fixed effects and time fixed effects capture the possible relevance of respectively cross-section and time-specific variation in regional wages. But, see also Overman, Rice and Venables (2008, eq. 8), besides density there are maybe also other determinants of wages that vary in the cross-section as well as time dimension like human capital or the region's economic structure that one may want to include in the estimation.[8]

For our paper it is important to note that equations (1) and (2) do not include variables that capture the spatial interdependencies between regions in the sense that somehow other regions have an impact on the wages in region *r*. As we argued in section 2, this is a key between urban economics and NEG. For economic geographers Harris's market potential (Harris, 1954) already highlighted the role of interregional spatial linkages, but NEG gives a more sophisticated analysis of market potential. In empirical applications Harris's simple market potential function is, however, still a good starting point as we will illustrate next. The short-run equilibrium wage equation in NEG is the counterpart to wage equation (1) above. Equation (3) summarizes the by now well-known NEG wage equation[9]:

(3) $\ln w_r = \frac{1}{\sigma} \ln RMP_r - \frac{1}{\sigma} \ln\left(\frac{a}{c}\right)$, where $RMP_r = \sum_s \phi_{rs} \delta_s Y_s P_s^{\sigma-1}$, with $\phi_{rs} = \tau_{rs}^{-(\sigma-1)}$,

a = constant, $c = \sigma^{-\sigma} / (\sigma - 1)^{-(\sigma-1)}$; δ_s = the share of the good in income, Y_s, of s; P_s = is a price index; τ_{rs} = the iceberg transportation costs between regions r and s; σ = elasticity of substitution, with $\sigma > 1$.

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[8] Ideally, one would like to have micro-data to estimate (2), see Combes, Duranton and Gobillon (2008).

[9] See the appendix for a derivation

The important thing to note from equation (3) is that wages, that a firm in region r can afford, depends on *RMP* which stands for *Real Market Potential*. This term describes the location of a region with respect to surrounding regions. Regions might be attractive because they represent a large market, reflected by $\delta_s Y_s$, but if the distance to these markets is large, reflected by $\tau_{rs}^{-(\sigma-1)}$ this positive effect is reduced. Together these two forces determine the market potential of a region *r*. The inclusion of a price index *P* is responsible for the 'Real' in RMP. If the distance to other markets is large, which results in high prices in the destination markets, market *r* is also shielded from competition which results in higher local prices and thus higher wages. Note, that the price index P_s does not measure a competition effect in the sense in which this term is normally used (there is no strategic interaction between firms). A low price index reflects that many varieties are produced in nearby regions and are therefore not subject to high transportation costs; this reduces the level of demand for local manufacturing varieties. Since by assumption in this model a firms' output level and price mark-up are fixed, this has to be off set by lower wages.

Equation (3) differs fundamentally from (1) because the location of a specific region is defined with respect to all other regions. Not only determinants of the region itself determine local wages, but also those of other regions. This was the essential contribution of Krugman (1991). Some disadvantages of equation (3) for empirical purposes are, however, immediately clear. Trade or transport costs have to be approximated by a trade costs function because of the lack of (sufficient) transport data. In a regional context price indices are not available. Furthermore, the price index depends on wages of all regions (because of mark-up pricing), including the wage in the home region that receives a large weight because transport cost to the own region is small. Many estimates of NEG models try to fix these and other problems (see Combes and Overman, 2004, Head and Mayer, 2004, Combes, Mayer and Thisse (2008, ch. 12) or Brakman, Garretsen, and Van Marrewijk, 2008, ch. 5 for a survey of these attempts). With respect to equation (3) one can include control variables that besides market potential could also account for spatial wage differences between regions. Apart from time and region fixed effects, human capital and (!) density can also be included (Breinlich, 2006, Hering and Poncet, 2006).[10] As a 1st pass (and driven in no small part by data availability), we reformulate of equation (3) in terms of Harris's simple market potential, where we proxy *RMP* from equation (3) by *MP*, so:

(4) $\ln w_r = \beta_1 + \beta_2 \ln MP_r + \varepsilon_r$, with $MP_r = \sum_s \frac{\delta_s Y_s}{d_{rs}}$ and $d_{rs} = 1/\phi_{rs}$. Implicitly it is assumed that price do not vary across regions. Note that MP can include the own region's income. In order to distinguish own region effects from foreign region effects we should distinguish between *domestic* and *foreign* MP, where foreign MP excludes the own region and provides as such the clearest contrast with wage equation (2).

4 Data set and summary statistics

We examine (changes in) over time in the degree of spatial interaction at different levels of aggregation within Europe. In doing so, we decided to restrict our sample to 14 European countries from 1870 onwards and to (if applicable) the corresponding NUTSII region data (available from 1975 onwards). This results in 213 NUTSII regions. The main data source for the country data is Maddison (2008) and for the regional data we used data from Eurostat and Cambridge Econometrics. Our choice to cover both countries and regions and to do so for a rather long time-period has drawbacks as well. We lack data on for instance price indices and control variables like human capital. Similarly, and following for instance Redding and Venables (2004), we lack data on wages and use GDP per capita instead.

4.1 Country data

Using the data set Angus Maddison (2008) data we selected fourteen countries in Europe for which annual data on income (GDP) and population were available for the period 1870-2006, see Figure 1 and Table 1 below. The 14 countries are Austria, Belgium, Denmark, Finland, France, Germany, Italy, The Netherlands, Norway, Sweden, Switzerland, UK, Portugal and Spain.

[10] Density can be looked upon in terms of equation (3) as controlling for the fact that technology differs across regions, Bosker and Garretsen (2008b) see also the 2nd term, besides RMP, in wage equation (3).

Figure 1 Selection of European countries

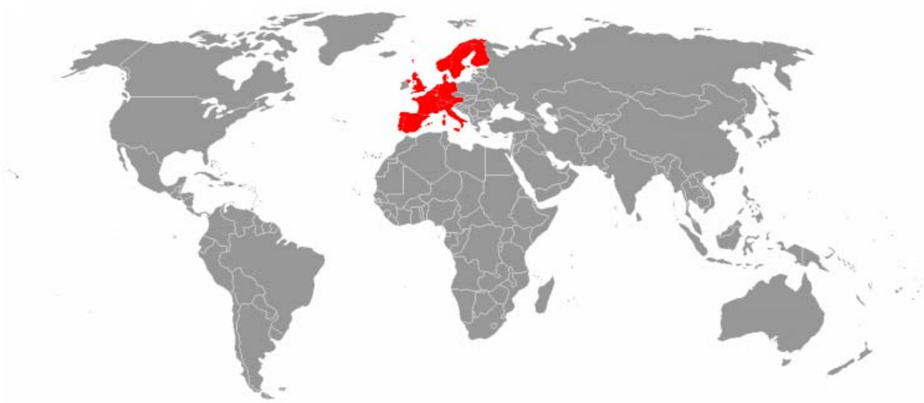

Table 1 Fourteen European countries; summary statistics, 1870-2006

	AUT	BEL	DNK	FIN	FRA	DEU	ITA
Mean GDP	51	71	39	28	389	526	327
st err GDP	4.3	5.4	3.3	2.8	33.2	41.5	29.9
Mean POP	6.7	8.2	3.8	3.7	45.5	65.8	44.0
st err POP	0.1	0.1	0.1	0.1	0.6	1.1	0.9
Mean GDP/cap	6,905	7,748	8,407	6,253	7,579	7,122	6,299
st err GDP/cap	521	486	568	521	544	486	496
# observations	137	137	137	137	137	137	137
Growth rates (gr, %)							
Mean GDP gr	2.67	2.20	2.74	3.16	2.48	2.68	2.63
st err GDP gr	0.63	0.35	0.32	0.38	0.64	0.65	0.49
Mean POP gr	0.44	0.52	0.78	0.80	0.34	0.54	0.53
st err POP gr	0.06	0.04	0.03	0.05	0.06	0.09	0.03
Mean GDP/cap gr	2.21	1.64	1.94	2.34	2.11	2.08	2.07
st err GDP/cap gr	0.63	0.35	0.32	0.39	0.60	0.61	0.48
# observations	136	136	136	136	136	136	136

	NLD	NOR	SWE	CHE	GBR	PRT	ESP
Mean GDP	98	29	60	57	437	36	162
st err GDP	9.1	3.0	5.0	4.6	28.7	3.7	16.7
Mean POP	9.4	3.1	6.6	4.8	48.1	7.5	27.0
st err POP	0.4	0.1	0.1	0.1	0.7	0.2	0.7
Mean GDP/cap	8,111	7,568	7,717	9,790	8,355	3,944	4,806
st err GDP/cap	514	642	543	603	446	347	392
# observations	137	137	137	137	137	137	137
Growth rates (gr, %)							
Mean GDP gr	2.98	3.05	2.61	2.68	2.00	2.75	2.84
st err GDP gr	0.66	0.31	0.26	0.39	0.26	0.36	0.40
Mean POP gr	1.11	0.72	0.56	0.76	0.48	0.66	0.67
st err POP gr	0.04	0.03	0.03	0.05	0.05	0.04	0.03
Mean GDP/cap gr	1.83	2.31	2.03	1.89	1.50	2.08	2.15
st err GDP/cap gr	0.65	0.31	0.26	0.38	0.25	0.36	0.40
# observations	136	136	136	136	136	136	136

AUT=Austria; BEL=Belgium; DNK=Denmark; FIN=Finland, FRA=France; DEU=Germany; ITA=Italy; NLD=Netherlands; NOR=Norway; SWE=Sweden; CHE=Switzerland; GBR=United Kingdom; PRT=Portugal; ESP=Spain. St err = standard error. Income measured in 1990 international Geary-Khamis dollars; GDP in billions; GDP per capita in units. Population measured in millions. Growth rates in percent.

With respect to our dependent variable, GDP per capita, we are for instance interested in the geographical or spatial reach, if any, of contemporaneous interactions in economic activity. Let I denote the group of countries and T the periods of observation.[11] The indices $i, j \in I$ will refer to countries and the indices $t, t_0, t_1 \in T$ to time periods. Let x_{it} and x_{jt} be measures of country *i*'s and country *j*'s (change in) economic activity in period *t*. A standard measure of the degree of contemporaneous interaction over the period from t_0 to t_1 is then given by the correlation coefficient $\rho(x_i, x_j; t_0, t_1)$, as defined in equation (5). We focus on x as growth rate of GDP per capita. The correlation coefficient for any pair of countries between the level of GDP pr capita is less interesting because it is invariably very high (0.99 or thereabout).

(5)

$$\rho(x_i, x_j; t_0, t_1) \equiv \frac{\sum_{t=t_0}^{t_1} (x_{jt} - \bar{x}_j)(x_{it} - \bar{x}_i)}{\sqrt{\sum_{t=t_0}^{t_1} (x_{jt} - \bar{x}_j)^2 \sum_{t=t_0}^{t_1} (x_{it} - \bar{x}_i)^2}}; \quad t_1 \geq t_0; \quad \bar{x}_k \equiv \frac{1}{t_1 - t_0} \sum_{t=t_0}^{t_1} x_{kt}, \quad k = i, j$$

Figure 2I illustrates the extent of contemporaneous spatial interaction of changes in economic activity for the period as a whole using the GDP per capita growth rate (panel a), the GDP growth rate (panel b) and the population growth rate (panel c).[12] We calculated, for example, the correlation coefficients for all country-pairs of the GDP per capita growth rates for the period as a whole and depict these relative to the weighted bilateral distance between the country-pair as provided by the CEPII website.[13] Evidently, there seems to be no relationship between GDP activity and spatial reach, as suggested by the horizontal trend line in Figures 2Ia,b. Matters are different regarding the spatial reach of population growth interactions, see the downward sloping trend line in Figure 2I.b. The highest correlation coefficient for population growth (0.672) is reached for Norway and Sweden, whereas the lowest (-0.281) is reached for Switzerland and Portugal. Preliminary conclusions drawn from Figure 2I are, however, *misleading* as it for instance lumps together all experiences for Europe for the whole period 1870-2006, during which two World Wars (1914-

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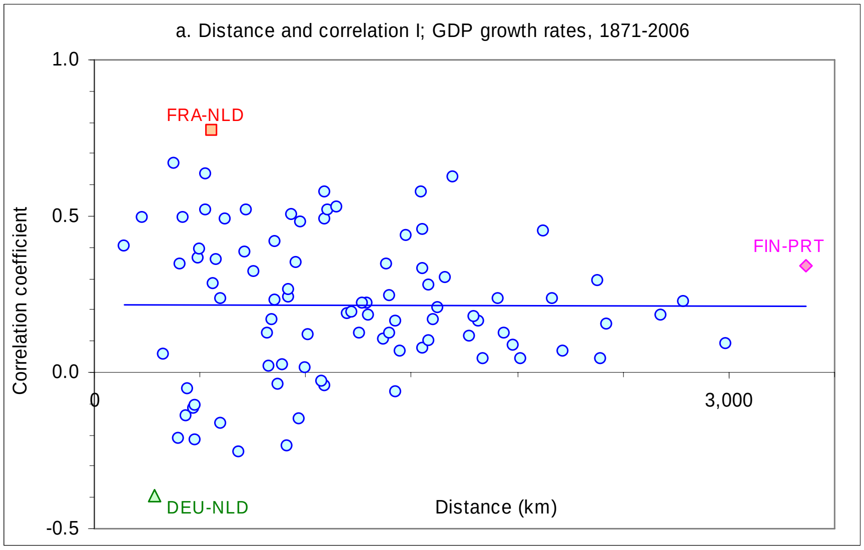
[11] So $I = \{AUT, BEL, DNK, FIN, FRA, DEU, ITA, NLD, NOR, SWE, CHE, GBR, PRT, ESP\}$ and $T = \{1870, 1871, ..., 2006\}$.

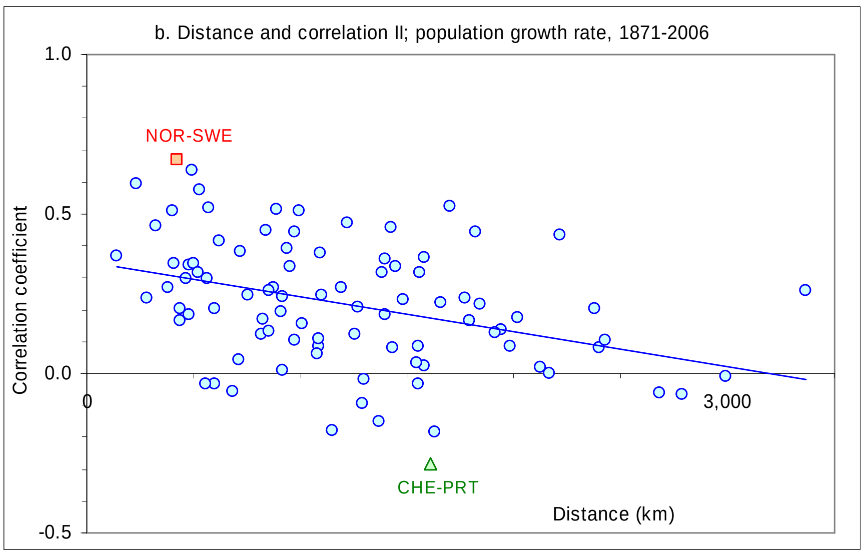
[12] The GDP per capita panel (not shown) is very similar to the GDP panel.

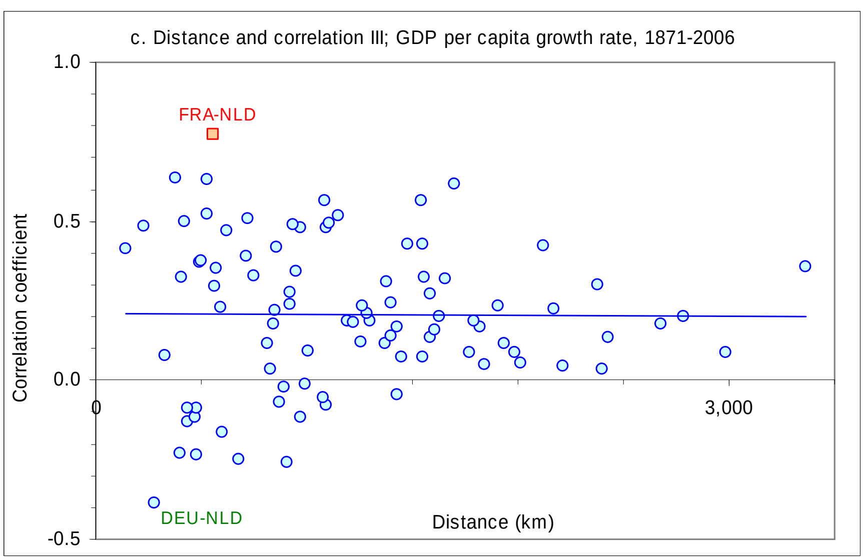
[13] Since there are 14 countries we have 14 × 13 / 2 = 91 country-pairs.

1918 and 1939-1945) and the impact of the Great Depression (starting 1929) severely interrupted the ‘normal’ economic relationships. A similar exercise for sub-periods showed that indeed the relationship between these correlations and bilateral distance differ markedly between sub-periods (for GDP per capita there is for instance a clear negative trend line for the period 1871-1911 and 1966-2006, correlations are typically higher when the 2 countries involved are less far apart). Also, the pair-wise correlations and the connection with bilateral distance only provides, of course a rather narrow view on the relevance of economic geography in the sense that gdp per capita growth rate are spatially correlated.

Figure 21 Spatial extent of economic interaction, 1871-2006

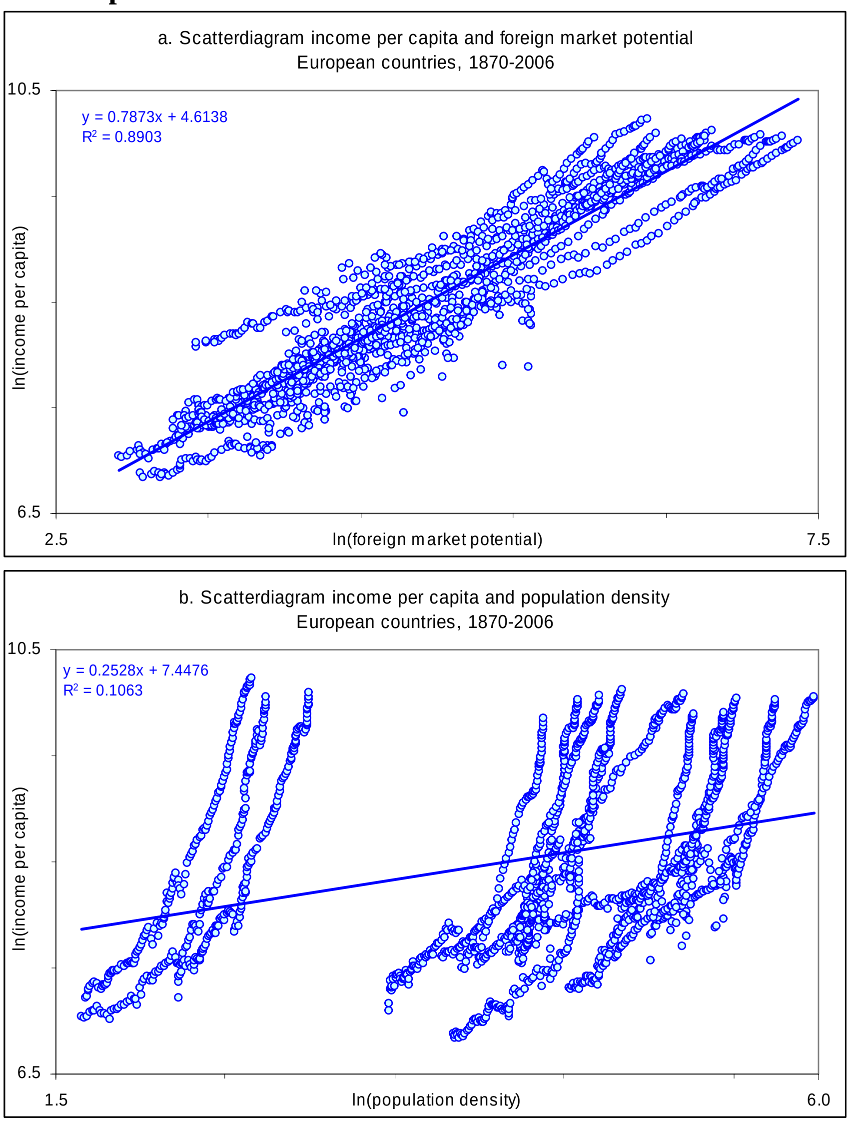


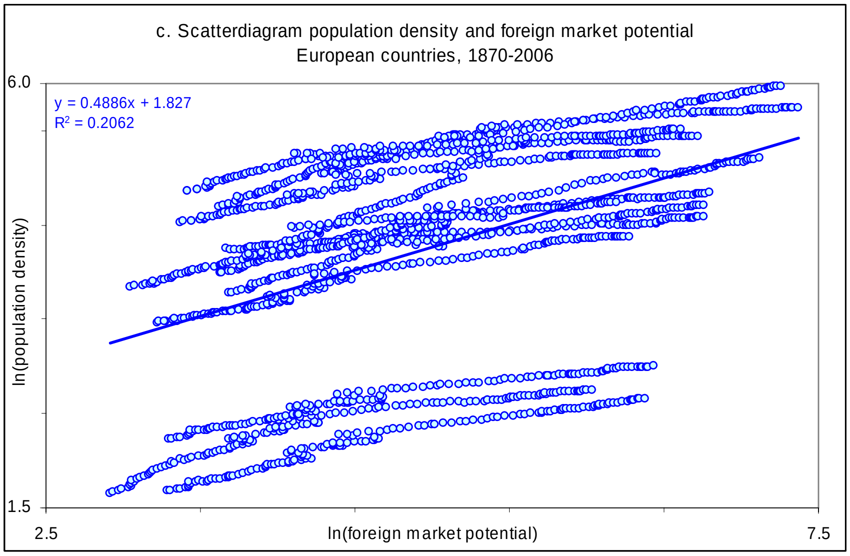




Our main explanatory variables are density and market potential. Figure 2II visualizes these variables with respect to GDP per Capita in to each other. What is immediately clear from Figure 2II panel a is that GDP per capita and foreign market potential are strongly related. Panel b reveals that density and GDP per capita are also positively related, but in a more complicated way. Countries with high density levels also have higher GDP per capita, but developments in density over the period 1870-2006 do not seem to effect GDP per capita. This suggests that only relative developments in density seem to matter. Panel c finally shows that our two main explanatory variables are not strongly related.

Figure 2II. GDP per Capita, Foreign Market Potential and Population Density for European countries 1870-2006





4.2. Data on European regions

Figure 3I shows some summary statistics of our data set on 213 European regions. The bottom part of the table indicates that the correlation between GDP per capita and foreign market potential is high, but lower than comparable correlations with respect to countries. On the other hand the correlations with respect to density are lower than with respect to countries.

Table 2I. 213 European regions; summary statistics, 1975-2006

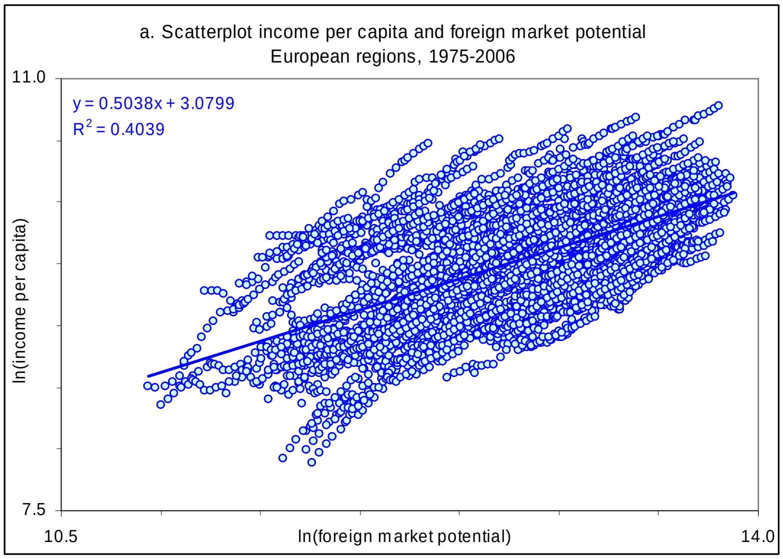
	ln(for mar pot)	ln(gdp/cap)	ln(pop dens)	ln(work pop dens)
Mean	12.80	9.53	4.95	4.52
St. error	0.007	0.005	0.016	0.016
Median	12.88	9.59	4.95	4.49
Kurtosis	-0.47	-0.21	0.92	0.93
Skewness	-0.48	-0.34	0.13	0.10
Minimum	10.94	7.89	1.18	0.61
Maximum	13.88	10.78	9.09	8.73
Count	6,816	6,816	6,816	6,816
correlation coefficients				
	ln(for mar pot)	ln(gdp/cap)	ln(pop dens)	ln(work pop dens)

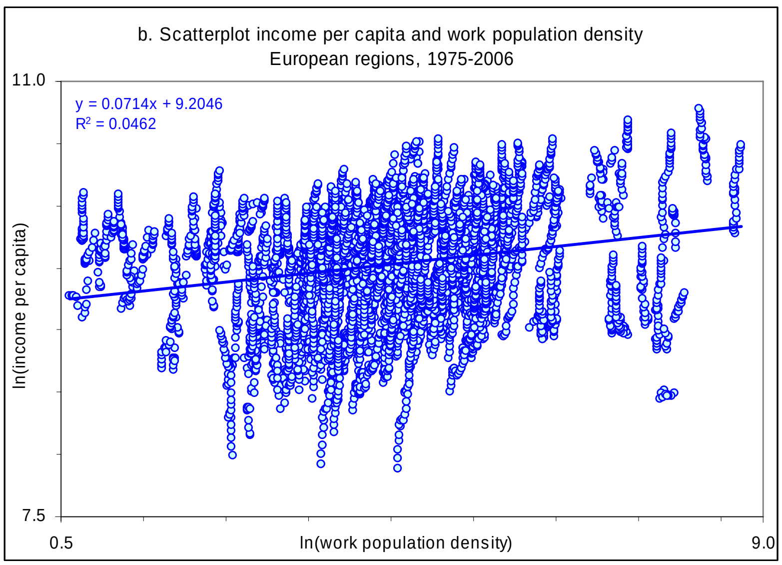
1	1.000			
2	0.636	1.000		
3	0.472	0.212	1.000	
4	0.476	0.215	0.999	1.000

For mar pot = foreign market potential; gdp/cap = income per capita (constant 1995 euro); pop dens = population density (people/km^2); work pop dens = working population density (people/km^2)

In Figure 3I we again look at our two main explanatory variables with respect to regions. The remarks are to some extent a repetition of the earlier remarks with respect to the same variables for countries. From Figure 3I panel a, is that GDP per capita and regional foreign market potential are related, but not as strong as in the country case. Panel b, reveals that density and GDP per capita are also positively related, but in a more complicated way. Regions with high density levels also have higher GDP per capita, but developments in density over the period 1975-2006 do not seem to effect GDP per capita. This again suggests that only relative developments in density seem to matter.

Figure 3I GDP per Capita, Foreign Market Potential and Population Density for European regions, 1975-2006





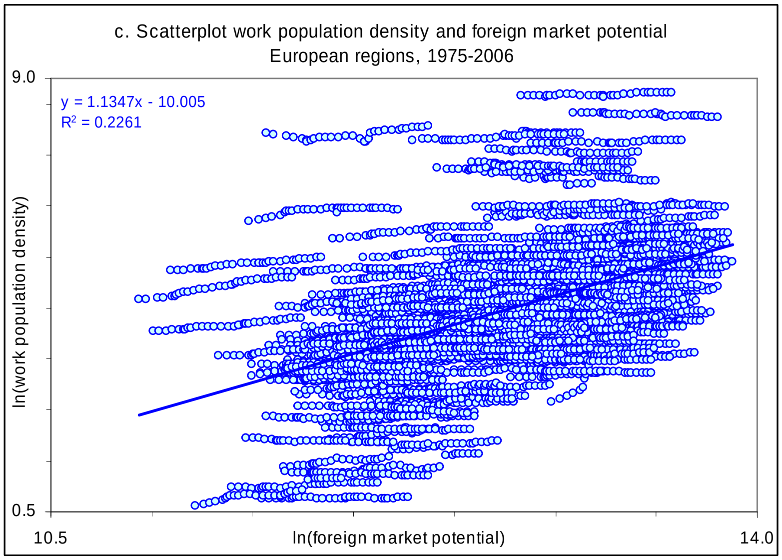
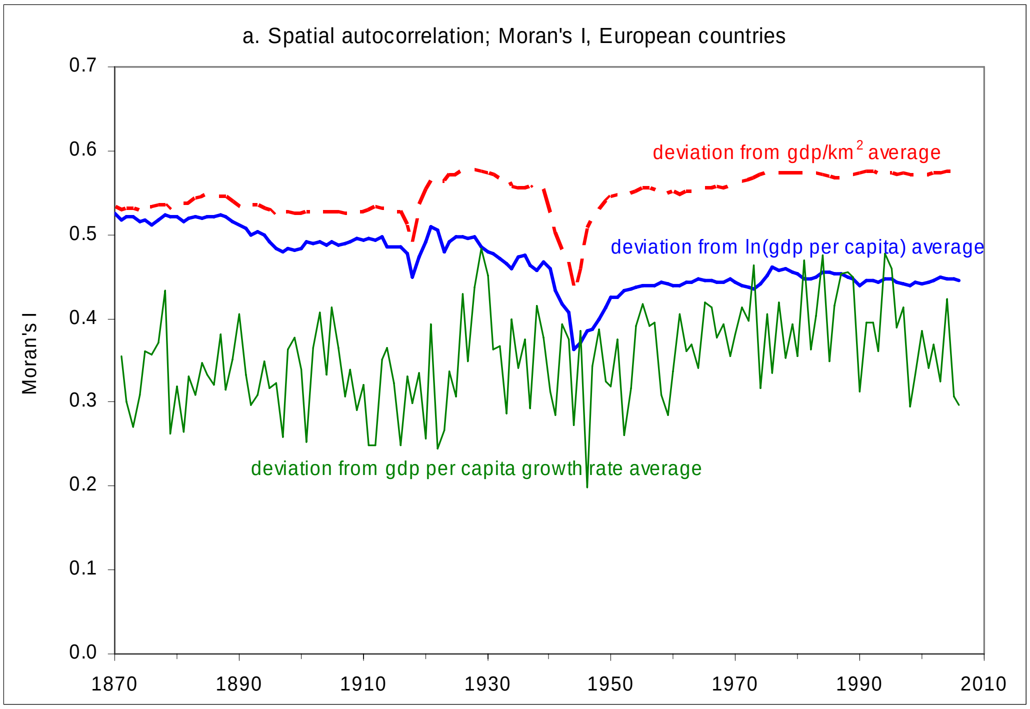
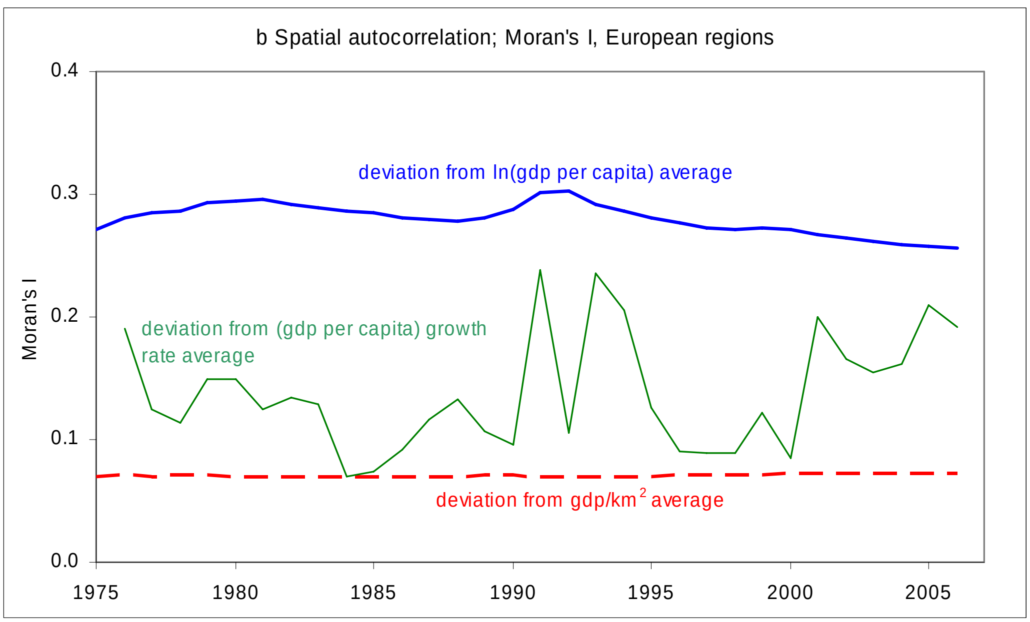


Figure 4 corroborates these conclusions with the help of Moran's I. This simple measure of spatial autocorrelation reveals that indeed spatial autocorrelation for the country level is larger than for regions. This holds for GDP/km^2 as well as for GDP per capita. Our conclusion based on these descriptive statistics is that on the country level of aggregation the effects of foreign market potential are more important than on the level of regions. On this lower level of aggregation the effects of density (urbanization) could be more important than on more aggregated levels.

Figure 4 Moran's I





5 Estimation results

In this section we present our main estimation results. We thus basically set out to estimate the "density" equation (2) and the "market potential" equation (4) for our sample of 213 European regions (section 5.1) and 14 European countries (section 5.2). In doing so, we are not only interested in the possible different outcomes for these two spatial scales but also in the possible changes in the relevance of density or market potential over time.

5.1 Regional income, density and market potential

Table 2 (panel a) shows the estimation results for GDP per capita in simple OLS regressions. These results indicated that there is a positive correlation between (nominal) market potential and income per capita for our sample period of 32 years between 1975-2006. Note that market potential does not include the own-region's income; this variable is the so-called foreign market potential. Density is alternatively measured as population density or as working population density. Density is preferred over absolute population, because sizes of regions (or countries) are often determined outside the model (see Glaeser, 2008 for a discussion).

The third column (panel a) shows that taken in isolation, there is a positive correlation between density and income per capita. But when both market potential and density are included the coefficient of density becomes negative. But these are just simple OLS regressions, the panel estimation results are more informative (panel b). The panel estimates include country and time fixed affects to deal with non-observed factors that also are important for GDP per capita. It would be very remarkable if only the variables that are of interest in this paper would explain the bulk of GDP per capita. The inclusion of fixed effects increases the explanatory power of the estimates. Foreign market potential and the two measures of density contribute positively on GDP per capita, as do the combined effects of foreign market potential and each of the density variables. Note, that the MP coefficients are lower than those in the associated OLS cases. The main conclusion from Table 3, is that both market potential and density are significant and have a positive impact on regional income per capita. This suggests that on this level of aggregation geography matters. Having said this, see also the concluding section 6, the relevance of interregional spatial linkages is subject to at least two important caveats. First, both density and MP are potentially endogenous. To correct for this, we also performed IV estimations. Second, we may overestimate the role of MP or density because due to limited data availability did not include other possible time and cross-section *varying* independent variables (like human capital). Variables like human capital or interregional trade are not, or not sufficiently available for the NUTSII regions (see also Breinlich, 2006).

Table 3 Income per capita, market potential, and density, European regions
Dependent variable is ln(income per capita), t-statistics in parentheses

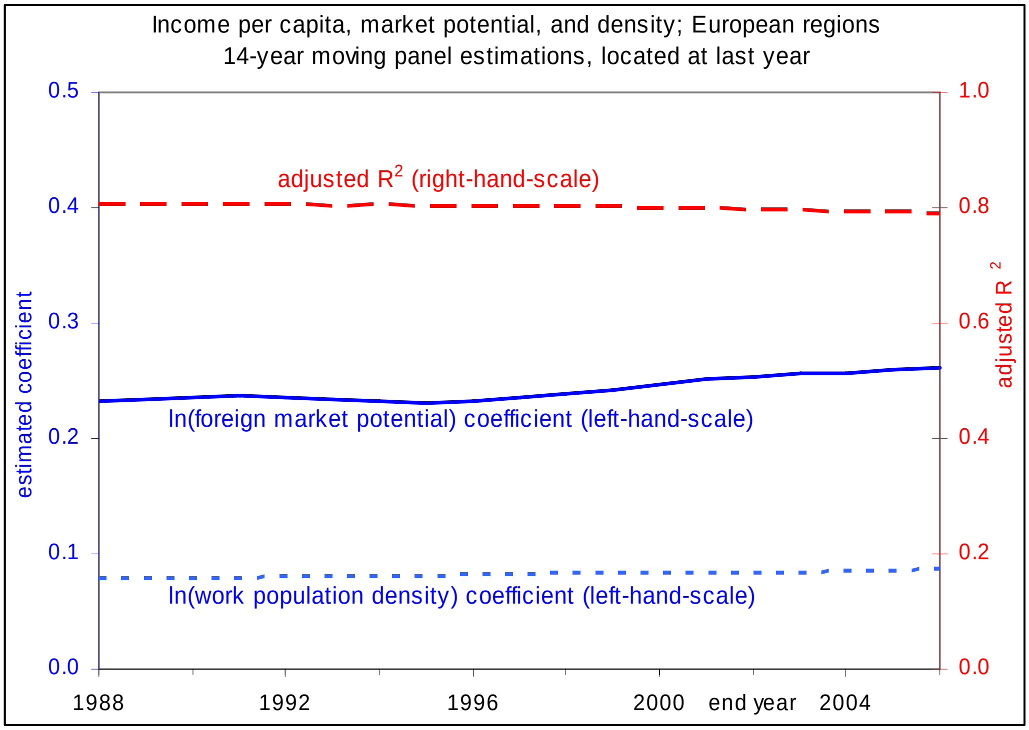
a. Simple OLS regressions					
Ln(foreign market potential)	0.504 (32.4)			0.546 (65.5)	0.546 (65.4)
Ln(population density)		0.072 (17.9)		-0.038 (-10.7)	
Ln(work population density)			0.071 (18.2)		-0.037 (-10.7)
$\overline{R}^2$	0.404	0.045	0.046	0.414	0.414
F-statistic	4,617	322	330	2,405	2,404
Observations	6,816	6,816	6,816	6,816	6,816
b. Panel estimates					
Ln(foreign market potential)	0.321 (36.7)			0.255 (23.4)	0.252 (23.3)
Ln(population density)		0.090 (37.9)		0.081 (34.7)	
Ln(work population density)			0.092 (39.1)		0.082 (35.8)
Time fixed effects	yes	yes	yes	yes	yes
Country fixed effects	yes	yes	yes	yes	yes
$\overline{R}^2$	0.782	0.800	0.802	0.815	0.817
F-statistic	521	580	588	625	633
Observations	6,816	6,816	6,816	6,816	6,816

We performed two robustness checks. First we look at the regional estimation results over time. Second we include instruments to deal with (potential) endogeneity problems. Table 4 therefore gives for 14-year periods (starting with 1975-1988; the years in the table specify the end dates of each of the 14-year periods) the estimation results for the same specification as in the last column of panel b in Table 3. The value of the foreign MP coefficient increases slightly over time (from 0.233 to 0.261) whereas the density coefficient remains almost unchanged. Figure 5 visualizes the changes over time in the adj. R^2 (right hand scale), the MP coefficient and density coefficient (left hand scale).

Table 4 Income per capita, market potential, and density, European regions
Dependent variable is ln(income per capita), t-statistics in parentheses
Panel estimates with time fixed effects and country fixed effects

end year 14-year period	1988	1989	1990	1991	1992
Ln(foreign market potential)	0.233	0.234	0.236	0.237	0.236
	(14.3)	(14.4)	(14.6)	(14.7)	(14.7)
Ln(work population density)	0.079	0.079	0.079	0.080	0.080
	(22.8)	(23.0)	(23.1)	(23.3)	(23.5)
$\overline{R}^2$	0.806	0.806	0.806	0.806	0.806
F-statistic	414	415	414	414	443
Observations	2,982	2,982	2,982	2,982	2,982
end year 14-year period	1993	1994	1995	1996	1997
Ln(foreign market potential)	0.234	0.232	0.231	0.232	0.235
	(14.6)	(14.6)	(14.6)	(14.7)	(15.0)
Ln(work population density)	0.080	0.081	0.081	0.082	0.083
	(23.7)	(23.9)	(24.2)	(24.5)	(24.8)
$\overline{R}^2$	0.805	0.806	0.805	0.804	0.803
F-statistic	410	424	424	424	407
Observations	2,982	2,982	2,982	2,982	2,982
end year 14-year period	1998	1999	2000	2001	2002
Ln(foreign market potential)	0.238	0.242	0.247	0.251	0.254
	(15.2)	(15.6)	(15.9)	(16.1)	(16.2)
Ln(work population density)	0.084	0.084	0.084	0.084	0.084
	(25.3)	(25.4)	(25.4)	(25.4)	(25.4)
$\overline{R}^2$	0.803	0.802	0.801	0.799	0.797
F-statistic	406	404	402	397	392
Observations	2,982	2,982	2,982	2,982	2,982
end year 14-year period	2003	2004	2005	2006	all
Ln(foreign market potential)	0.256	0.257	0.259	0.261	0.252
	(16.3)	(16.3)	(16.4)	(16.5)	(23.3)
Ln(work population density)	0.084	0.085	0.086	0.087	0.082
	(25.4)	(25.6)	(25.7)	(25.9)	(35.8)
$\overline{R}^2$	0.796	0.795	0.793	0.791	0.817
F-statistic	388	386	382	377	633
Observations	2,982	2,982	2,982	2,982	6,816

Figure 5



5.2 Country income, density and market potential

This section is largely a repetition of section 5.1, but at a different level of aggregation. Table 5I gives OLS estimates (panel a) and panel estimates (panel b). In a qualitative sense panel a in Table 5I leads to similar remarks as did panel a in Table 3; when both market potential and density are included the coefficient of density becomes negative. Note that Table 5I differs from Table 3 in the sense that two different measures of foreign market potential are included – GDP and Population - and one measure for density, population density. Separately the three variables contribute positively to GDP per capita. Combining each of the foreign MP variables, with density measures leads to a negative coefficient for density in both cases. Again panel estimates are preferred as these allow us to incorporate country and time fixed effects that capture possibly important non-observed variables. In contrast to the region estimates, panel estimation results in a negative contribution for density. One possibility that might explain this is that in the panel we look at a very long period; 1860 – 2006. Figure 2II suggests trend correlation. In table 5II first differences are presented. These estimates corroborate the findings presented in Table 5I; foreign market potential on the country level of aggregation is more important than density (both measures). Table 6 shows the results for 32 year periods (the years in the table refer to the last years in each 32 year period).

Table 5I Income per capita, market potential, and density, European countries
Dependent variable is ln(income per capita), t-statistics in parentheses

a. Simple OLS regressions					
Ln(for. market pot. gdp)	0.787 (124.7)			0.836 (125.8)	
Ln(for. market pot. pop)		1.238 (37.1)			1.485 (33.7)
Ln(population density)			0.253 (15.1)	-0.100 (-16.2)	-0.150 (-8.4)
$\overline{R}^2$	0.890	0.418	0.106	0.903	0.438
F-statistic	15,553	1,378	228	8,966	749
Observations	1,918	1,918	1,918	1,918	1,918
b. Panel estimates					
Ln(for. market pot. gdp)	0.353 (5.0)			0.405 (5.8)	
Ln(for. market pot. pop)		1.754 (7.9)			2.603 (11.2)
Ln(population density)			0.216 (5.6)	0.242 (6.3)	0.389 (9.6)
Time fixed effects	Yes	yes	yes	yes	yes
Country fixed effects	Yes	yes	yes	yes	yes
$\overline{R}^2$	0.963	0.964	0.963	0.964	0.966
F-statistic	1,231	1,257	1,235	1,227	1,288
Observations	1,918	1,918	1,918	1,918	1,918

Table 5II Income per capita, market potential, and density, European countries
Dependent variable is dln(income per capita), t-statistics in parentheses

a. Simple OLS regressions					
dln(for. market pot. gdp)	0.333 (8.9)			0.322 (8.8)	
dln(for. market pot. pop)		0.573 (2.0)			0.002 (0.0)

dln(population density)			7.467 (7.5)	1.483 (7.3)	1.552 (7.2)
$\overline{R}^2$	0.040	0.002	0.028	0.065	0.027
F-statistic	80.0	4.0	55.8	67.5	27.9
Observations	1,904	1,904	1,904	1,904	1,904
b. Panel estimates					
dln(for. market pot. gdp)	0.123 (2.8)			0.133 (3.1)	
dln(for. market pot. pop)		-0.978 (-2.3)			-0.961 (-2.3)
dln(population density)			1.793 (7.7)	1.814 (7.8)	1.790 (7.7)
Time fixed effects	Yes	yes	yes	yes	yes
Country fixed effects	No	no	no	no	no
$\overline{R}^2$	0.080	0.079	0.105	0.109	0.107
F-statistic	5.0	5.0	6.4	6.5	6.4
Observations	1,904	1,904	1,904	1,904	1,904

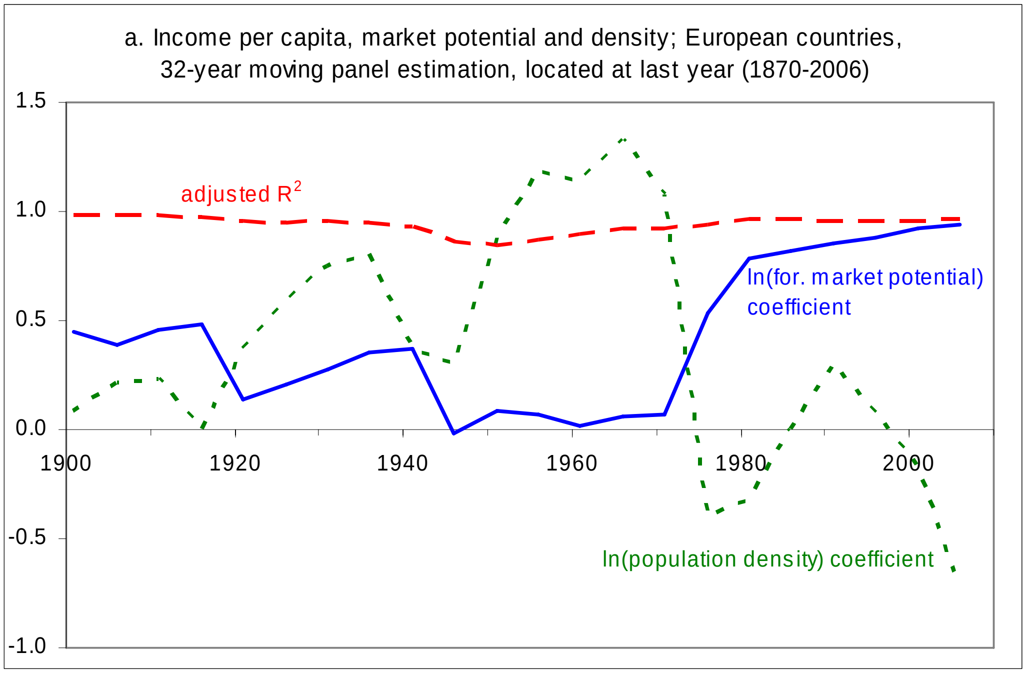
Table 6 gives panel estimates – with country and time fixed effects.[14] Market potential is always positive except for the period that ends in 1946, and includes the economic crisis of the 1930s and the war period. Apparently for this period foreign market potential is negative, which can be expected for a period including these major events. Density is revealed as a much more volatile variable; both positive and negative values for the coefficients are observed, as is visualized in figure 6. Figure 6 panel a, shows the development of estimated coefficients for both foreign MP (left hand scale) and density (right hand scale). Compared to the region estimates when is tempted to conclude that density is less important on the country level of observation than on the region level of observation. All other factors given foreign MP seems to dominate. Figure 6 panel b, shows significance, and indicates that this observation especially holds for the more recent periods.

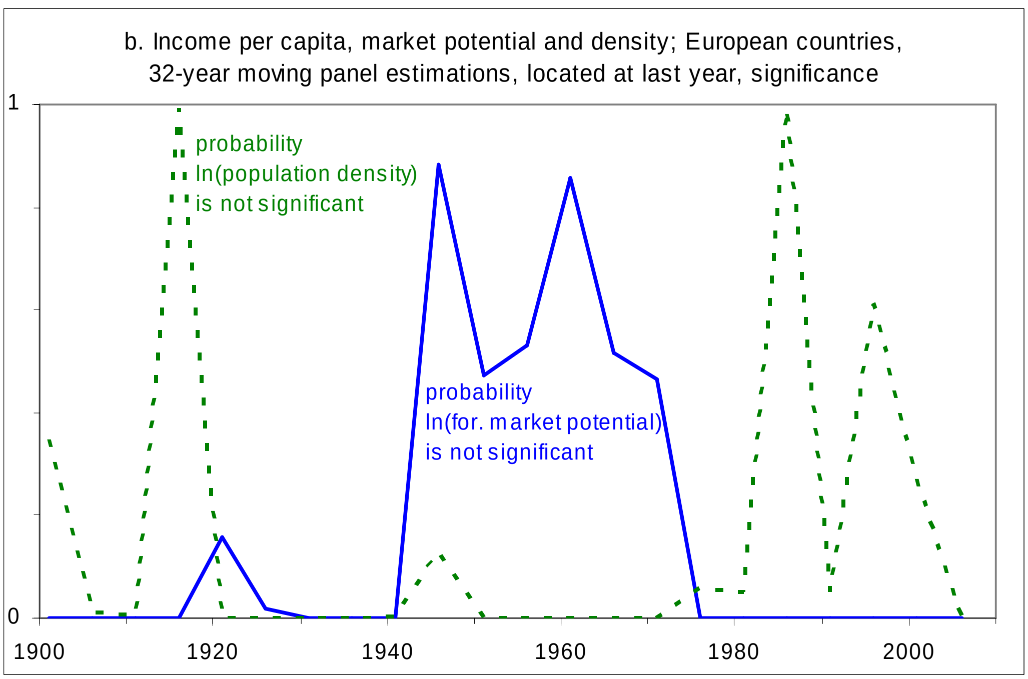
[14] Table 6 gives shows one of the two foreign MP measures (GDP), to avoid that the table becomes too large. Measuring foreign MP with population gives similar results and these are available upon request.

Table 6 Income per capita, market potential, and density, European countries
Dependent variable is ln(income per capita), t-statistics in parentheses
Panel estimates with time fixed effects and country fixed effects

end year 32-year period	1901	1906	1911	1916	1921	1926
Ln(foreign market potential)	0.444	0.389	0.456	0.482	0.139	0.209
	5.9	4.9	5.8	5.7	1.4	2.3
Ln(population density)	0.082	0.219	0.235	-0.001	0.370	0.593
	0.9	2.6	2.7	0.0	3.4	5.6
$\bar{R}^2$	0.981	0.982	0.980	0.975	0.955	0.952
F-statistic	1,089	1,148	1,028	825	457	426
Observations	448	448	448	448	448	448
end year 32-year period	1931	1936	1941	1946	1951	1956
Ln(foreign market potential)	0.280	0.353	0.370	-0.019	0.088	0.071
	3.4	4.1	3.9	-0.1	0.7	0.6
Ln(population density)	0.748	0.802	0.367	0.301	0.876	1.193
	7.5	7.7	2.9	1.5	4.0	5.7
$\bar{R}^2$	0.956	0.951	0.930	0.859	0.847	0.872
F-statistic	465	415	284	131	119	146
Observations	448	448	448	448	448	448
end year 32-year period	1961	1966	1971	1976	1981	1986
Ln(foreign market potential)	1961	1966	1971	1976	1981	1986
	0.019	0.062	0.072	0.539	0.782	0.823
Ln(population density)	0.2	0.7	0.7	5.8	10.6	11.1
	1.137	1.324	1.082	-0.398	-0.317	-0.002
$\bar{R}^2$	0.899	0.919	0.923	0.936	0.962	0.962
F-statistic	191	244	255	312	534	541
Observations	448	448	448	448	448	448
end year 32-year period	1991	1996	2001	2006		all
Ln(foreign market potential)	0.854	0.875	0.926	0.937		0.405
	12.4	12.4	13.0	12.6		5.8
Ln(population density)	0.306	0.078	-0.172	-0.720		0.242
	2.0	0.5	-1.1	-4.5		6.3
$\bar{R}^2$	0.961	0.960	0.958	0.962		0.964
F-statistic	523	506	488	535		1,227
Observations	448	448	448	448		1,918

Figure 6


a. Income per capita, market potential and density; European countries,
32-year moving panel estimation, located at last year (1870-2006)
1.5
1.0
0.5
0.0
-0.5
-1.0
1900
1920
1940
1960
1980
2000
adjusted R2
ln(for. market potential)
coefficient
ln(population density) coefficient


b. Income per capita, market potential and density; European countries,
32-year moving panel estimations, located at last year, significance
1
0
1900
1920
1940
1960
1980
2000
probability
ln(population density)
is not significant
probability
ln(for. market potential)
is not significant

6 Conclusions

The uneven spatial distribution of economic activity is a well-established stylized fact. Some regions or countries are able to attract the bulk of economic activity while others lag behind. Both economists and geographers seek to explain why this might be the case. Although the literature is huge, two views dominate the recent research in economics: urban economics and the new economic geography (NEG). A main difference between the two approaches is that urban economics neglects spatial interdependencies between regions whereas NEG stresses the relevance of the relative location of a region. Somewhat surprisingly empirical evidence on the relevance of the two theories for different aggregation levels is largely missing. This paper tries to fill this gap. The relevance of the two theories could depend on the level of aggregation and/or vary over time. It is often claimed that NEG is more likely to be relevant on more aggregated levels of measurements (nations), whereas local variables are more relevant on lower levels of aggregation such as regions.

In this paper we address this issue in a simple way: we test whether or not market potential and/or density is relevant on different aggregation levels. We find that, in general, geography or (foreign) market potential is more relevant on the country level, whereas density (or urbanisation) is more relevant on the regional level. Our findings support the consensus in the literature that NEG is best applied to countries.

Appendix Derivation of wage equations (1) and (3)

Derivation of equation (1)

The set-up is straightforward. Consider a firm j in region r, that uses labor, l, and a (composite) input, k, in its production process to produce y:

$y_j = A_j (s_j l_j)^{\mu} k_j^{1-\mu}$; where A_j = technology (Hicks-Neutral); μ = share of labor in the production process; s_j = labor productivity variable

The profits of this firm, that exports to all regions s, are:

$$\pi_j = \sum_s p_{js} y_{js} - w_j l_j - r_j k_j = p_j y_j - w_j l_j - r_j k_j \text{, where } p_j = \sum_s p_{js} \frac{y_{js}}{y_j}$$

where w_r = wage in region r; p_j = price of good j;; r_j = price of (composite of) other inputs.

The first order conditions are:

$w_j = \mu p_j A_j s_j^{\mu} \left(\frac{k_j}{l_j} \right)^{1-\mu}$, $r_j = (1-\mu) p_j A_j s_j^{\mu} \left(\frac{k_j}{l_j} \right)^{-\mu}$ substituting the second equation into the first gives the (individual) firm wage equation:

$w_j = \mu (1-\mu)^{(1-\mu)/\mu} s_j \left(\frac{p_j A_j}{r_j^{1-\mu}} \right)^{1-\mu}$, summing over all firms, n_r, in region r gives equation (1) in the text:

$$\text{(1)} \qquad w_r = \frac{\mu (1-\mu)^{(1-\mu)/\mu}}{n_r} \sum_{j \in r} s_j \left(\frac{p_j A_j}{r_j^{1-\mu}} \right)^{1-\mu}$$

Derivation of equation (3)

It is by now well-known that operating profits of a firm in region r operating in s – needed to cover the fixed costs of production - in a monopolistic competition setting can be formulated as follows:

$\pi_{rs} = (p_r - mc_r) \tau_{rs} q_{rs} = mc_r \frac{\tau_{rs} q_{rs}}{\sigma - 1}$, where p_r = is the mill-price of the product of a firm located in r; mc_r = marginal costs of this firm; τ_{rs} = the iceberg transportation costs between regions r and s; q_{rs} = the quantity that a firm located in r sells in s (it is multiplied by τ_{rs}; because a part of the product melts during transportation); σ = elasticity of substitution. The second equality follows from mark-up pricing over mc.

Assuming a CES-utility function, utility maximization gives:

$q_{rs} = (p_r \tau_{rs})^{-\sigma} \delta_s Y_s P_s^{\sigma-1}$, where $P_s = \left(\sum_r n_r (p_r \tau_{rs})^{-(\sigma-1)} \right)^{-1/(\sigma-1)}$, and δ_s = the share of the good in income of *s*.

Total profits – including fixed costs, F_r – can be derived as the sum over profits in all destination regions. Using the equations above and the definition of operating profits, total profits are:

$$\Pi_r = \sum_s \pi_{rs} - F_r = \sigma^{-\sigma} / (\sigma - 1)^{-(\sigma-1)} mc_r^{-(\sigma-1)} RMP_r - F_r,$$

where $RMP_r = \sum_s \phi_{rs} \delta_s Y_s^{\sigma-1} P_s^{\sigma-1}$

Assuming zero total profits we have, after rewriting:

$$mc_r = \left(\frac{\sigma^{-\sigma} / (\sigma - 1)^{-(\sigma-1)} RMP_r}{F_r} \right)^{1/(\sigma-1)}$$

We are now very close to a wage equation comparable to equation (1); we only have to model marginal costs. We can for example assume that the production process uses only labor, that is, marginal costs are for example, $mc_r = a w_r^{\alpha}$, substituting this in the equation above gives equation (3) in the main text:[15]

$$\ln w_r = \frac{1}{\sigma} \ln RMP_r - \frac{1}{\sigma} \ln \left(\frac{a}{c} \right), \text{ where } c = \sigma^{-\sigma} / (\sigma - 1)^{-(\sigma-1)}$$

[15] Using other inputs is straightforward and adds other costs factors.

References (to be completed)

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