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Agglomeration Economies, Inventors and Entrepreneurs as Engines of European Regional Productivity

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Abstract

In economic agglomeration studies, the distinction of various externalities circumstances related to knowledge spillovers remains largely unclear. This paper introduces human capital, innovation and several types of entrepreneurship as potential drivers of regional economic performance with an impact of agglomeration economies. We use measures of specific types of entrepreneurship, discerned at the individual level, as well as human capital and invention through patenting activity for the period 2001-2006. The empirical application on 111 regions across 14 European countries investigates their relation with observed regional productivity rates in 2006. Our main findings indicate that (i) human capital, patenting activity and entrepreneurship are all linked to regional performance, more so in regions containing large as well as medium-sized cities; (ii) they act as complements rather than substitutes, facilitating productivity differently; and (iii) accounting for patenting activity and entrepreneurship captures agglomeration externalities effects previously subscribed only to the density of resources of regional performance. The particular role of regions with medium sized cities next to regions with large cities complies with observed growth trends as well as recently proposed place-based development approaches that assume that interactions between institutions and geography are critical for regional economic performance.

Keywords: entrepreneurship, innovation, patents, agglomeration economies, regional competitiveness, regional performance

JEL classification: R12, L26, O30

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1. **Introduction**

The tendency of firms and workers to agglomerate their activities in space showed to be persistent throughout history. Theoretical and empirical studies in spatial economics have shown that agglomeration economies may be the most important source of this uneven distribution of economic activities and economic growth across cities and regions. Looking at the arguments behind this modern urbanization view, we find two relatively new approaches. One is based on the theory of agglomeration economies with increasing returns and easy access to knowledge (Krugman 2009), and a second is based on the idea that (larger) cities are strong because they are the physical concentration of skilled knowledge workers (Glaeser and Maré 2001). Both approaches lead to the hypothesis of expected higher labor productivity. This is confirmed in much empirical research. In Europe the largest urban areas, more in particular in the axis of London-Randstad-Paris-Frankfurt-Milan, contribute much more to their national GDPs than could be expected by looking at their population sizes (Ciccone 2002). The same conclusion has been made by Ciccone and Hall (1996) for the USA.

The empirical works on agglomeration economies are characterized by a large diversity of approaches. In Rosenthal and Strange (2004) there is a brief review of papers focusing on urbanization economies (being advantages of cities applying to every firm or consumer). Noticeable is that most of early (pre-1990's) works on agglomeration simply used the cities' population as a measure of agglomeration. These studies assume that the population elasticity of productivity is constant. Rosenthal and Strange (2004) conclude that this literature has found relatively consistent evidence: doubling the population of a city increases productivity by 3-8%.

Since Glaeser et al. (1992), it has become more apt to analyze growth variables using employment in cities, suggesting a relationship between agglomeration and economic growth, coining the possibility that urban increasing returns are working in a dynamic, rather than static, context. Sector-specific localization economies, stemming from input-output relations and transport cost savings of firms, human capital externalities and knowledge spillovers, are generally offset against the earlier customary measured general urbanization economies (Henderson 2003). A large literature builds on this conceptualization of agglomeration economies, reflected in three recent overview and meta-studies (Melo et al. 2009, Beaudry and Schiffauerova 2009 and De Groot et al. 2009). These studies show that the relation agglomeration-growth is ambiguous and indecisive on either specialization or diversity being facilitated by (sheer) urbanization as context. The ambiguity is fuelled by measurement issues and heterogeneity in terms of scale of time and space, aggregation, growth definitions, and the functional form of the models applied.

Based on an overview of historical and current conceptualizations of knowledge, knowledge diffusion and innovation in cities, several scholars plea for conceptual and methodological renewal and rigor in research in order to address this current impasse in economic agglomeration studies (Van Oort and Lambooy 2012). Only recently various conceptualizations of distance and proximity empirically address the heterogeneity in actors and processes involved, and capture the role of cities in this. It is argued that research should more and explicitly focus on both the transfer mechanisms of knowledge diffusion, like spin-offs, research collaborations, and social networks, and on the contexts that facilitate the acquaintance and diffusion of knowledge by individual firms. New methodological views appear needed here as well, in particular modeling techniques that link appropriate levels of analysis, from the firm to regional contexts and agglomeration circumstances (Van Oort et al. 2012).

The first goal of this paper is to take a step towards incorporating appropriate context and transfer mechanism issues in spatial externalities and productivity-agglomeration debate. Consistent with recent literature we argue that mechanisms embedded in entrepreneurship and innovation processes constitute a relevant additional explanation for observed regional and national variation in economic agglomeration and performance (Acs and Armington 2004; Acs and Varga 2005; Aghion et al. 2009; Fritsch and Mueller 2008; Acs et al. 2010; Bosma et al 2011). We argue that the nexus around invention, innovation and high quality entrepreneurship can be related to urbanization effects.

The second goal of the paper is to contribute to the recent policy discussion on place-based or place-neutral development strategies in the European Union. This debate is highlighted in the context of a series of recent major policy reports: the place-neutral policies in the 2009 World Bank report (World Bank 2009) and the European place-based development strategies in Barca (2009) and Barca et al. (2012). Place-neutral strategies rely on the agglomerative forces of the largest cities and metropolitan regions to attract talent and growth potential. Place-based development strategists claim that the polycentric nature of a set of smaller- and medium-sized cities in Europe, each with their own peculiar characteristics and specialising in the activities to which they are best suited, creates fruitful urban variety, which enhances optimal economic development. This implies that medium-sized city-regions have not declined in importance compared to larger urban ones, which has been indicated in monitoring publications by the OECD (2009, 2011), but there is until now little empirical support by explanations based in entrepreneurship, innovation and productivity. A related place-based regional policy dimension relevant for the European Union concerns objective-1 regions that have been supported in cohesion policy. Recent research shows that this distinction is important for productivity and productivity growth (Dogaru et al. 2011, Marrocu et al. 2012). This paper will therefore additionally test the relationship between productivity, innovation and entrepreneurship in distinctive large, medium-sized and small urban regions, as well as in objective-1 versus non-objective-1 regions simultaneously, and conclude on the place-based policy implications suggested in the recent discourse.

In order to reach the two research goals, this paper is structured as follows. In section 2 we introduce a synopsis of both relevant theories on agglomeration, entrepreneurship and innovation, as well as of the current place-based development strategies aimed for by the European Union. We argue that including regional innovation and entrepreneurship indicators captures additional localized externalities next to urbanization economies. In section 3 we present a model that formalizes this in a testable framework for 111 regions in 14 countries in Europe. In the empirical analysis we use data at the individual level from the Global Entrepreneurship Monitor (GEM) in 2001-2006, comprising information of entrepreneurship for over 350,000 working age adults and are we able to discern quality aspects of the entrepreneur. We make a distinction between early-stage entrepreneurs' growth expectation and their innovative orientation. Patent activity is used to capture potential innovation based on new inventions. These data and the estimation approach applied are discussed in section 4. Section 5 presents the results of 2SLS models in which regional productivity is explained by agglomeration economies, entrepreneurship and innovation indicators. We also introduce spatial regime analyses that distinguish the relationship between productivity and explanatory variables in objective-1 and non-objective-1 regions simultaneously, as well as in large, medium-sized and small urban regions in Europe. This explicitly tests for the suggested implications of place-based development trajectories that may be useful for policies on the local level instead of on the aggregate level. We present conclusions and a policy discussion in section 6.

2. **Entrepreneurship and Innovation as Nexus of Regional Productivity and Place-Based Development Strategies**

Agglomeration economies in need of conceptual renewal

The recent regional economic development literature has shown a renewed interest in agglomeration economies from the New Economic Geography (NEG) and the related empirical literature on economic geography and urban economics. Both sets of theories share the recently observed trend towards increased urbanization as an outcome. The new theoretical insights from NEG are in line with the empirical observation that inter-regional disparities in Europe, especially within countries, have grown since the 1980s. The evidence reviewed in Montfort (2009) leads to the conclusion that in the last ten to fifteen years disparities have diminished *among* countries and increased *within* countries. Theories on agglomeration advantages as an explanation for such observed spatial concentration of economic activities are increasingly used in economic geography (McCann and Van Oort 2009). The role of knowledge and human capital as a determinant of such economic growth has gained greater appeal after its incorporation in economic growth models. In these models, knowledge spillovers between economic agents play a crucial role in the growth and innovation process and lead to external economies of scale in production. New technological knowledge is seen as tacit, meaning that its accessibility, as well as its growth spillovers, is bounded by geographic proximity of high-tech firms and entrepreneurs or knowledge institutions. Also in endogenous growth theory, the generation of new knowledge and innovations is explained by increased investment in knowledge, like research and development (R&D). As knowledge is hard to appropriate, it generates benefits to other agents through several spillover mechanisms. Understanding the geographical structures that underlie these spillover benefits is necessary for any evidence-based innovation or growth policy to stimulate Europe's transformation towards a cohesive as well as knowledge economy society. Spatially bounded externalities (spillovers) are related to location decisions of firms or individuals (entrepreneurs) within their network. The driving mechanism in agglomeration economies is then that increased size of (urban) agglomerations leads to increased productivity, which will attract more people to migrate to larger agglomerations. This in turn will cumulatively cause higher productivity levels and higher economic growth.

The empirical evidence of agglomeration economies is strong, and in an overview paper by Rosenthal and Strange (2004) it is shown that a doubling in the size of an agglomeration leads to an increase in productivity between 3 and 8 per cent.

Melo et al. (2009), using a sample of 34 studies on agglomeration economies for 729 estimated values of elasticity, find a variation up to 29 per cent. In another meta-analysis considering 31 studies, de Groot et al. (2009) conclude that the theory provides 'strong indications for sectoral, temporal and spatial heterogeneity'. Beaudry and Schiffauerova (2009) confirm this view in their extensive - qualitative - overview of most recent agglomeration studies. Instaed of refining or standardizing existing localization and urbanization indicators in empirical research, it may be better to introduce more relevant indicators that capture knowledge spillover contexts more adequately (Van Oort & Lambooy 2012). We will do this in this paper by focussing on innovation and entreprneurship as a novel nexus of productivity in regions.

Regional innovation and entrepreneurship as externalities contexts

The link between agglomeration and regional performance resulting from innovation-based knowledge spillovers and entrepreneurship was first addressed by Audretsch and Feldman (1996). In their search for economic effects of entrepreneurship, thus far scholars have encountered two important phenomena. First, there is large heterogeneity within the broad category of entrepreneurship (Santarelli and Vivarelli 2007;Stam 2008). In empirical analyses most often a straightforward measure of new firm formation is used, but we know from the entrepreneurship literature that some types of entrepreneurship are more important for economic growth than others (Audretsch and Keilbach 2005; Acs 2008; Coyne et al. 2010). A second phenomenon is the pronounced uneven spatial distribution of entrepreneurship (in cities), which also seems to be persistent over time. Until now, studies on the geography of entrepreneurship have largely focused on (determinants of) spatial variations of (nascent) new firms (Keeble and Wever 1986; Reynolds et al. 1994; Acs and Storey (2004); Tamásy 2006; Koster 2007) or self-employment (Parker 2005). As such, these studies neglect the heterogeneity in entrepreneurship, like innovation oriented entrepreneurship and growth-oriented entrepreneurship versus imitative entrepreneurship. Some recent studies also confirm the need to integrate urbanization when linking entrepreneurship to growth, as the impact of entrepreneurship for regional growth may be higher in urban areas (Fritsch and Schroeter 2011; Bosma et al 2011).

Entrepreneurship and innovation are often expected to go hand in hand even though they are not the same. Conceptually, a positive effect of entrepreneurship on regional economic development is assumed via the commercialization of new combinations of resources (Schumpeter, 1942). The process of 'creative destruction' brings about competition and selection among both new and incumbent firms, resulting in more efficient producers which in the end fuels economic growth (e.g Aghion et al., 2009, Bosma et al., 2011). Holcombe (1998) argued that there is an entrepreneurial multiplier effect in the sense that entrepreneurship leads to more entrepreneurial opportunities through innovation. However, from the empirical literature we know that only a small part of the (new) firms owned and managed by entrepreneurs is innovative or ambitious in terms of growth. Referring to Baumol's categorization of entrepreneurship in productive, unproductive and destructive (Baumol 1990), Coyne et al (2010) argue that Holcombe's statement should be considered for both productive entrepreneurship and non-productive entrepreneurship. This means that creative destruction can also have negative outcomes when non-productive entrepreneurs behave as predators on the productive members of the (regional or national) society. Typical examples include lobbying activities by interest groups of incumbent entrepreneurs and rent seeking behaviour (Olsen 1982). In essence, non-productive entrepreneurship emerges from the established sets of firms in their attempts to reduce competition. Thus, focusing on early-stage entrepreneurship – and particularly promising types of entrepreneurship in terms of growth and innovation – seems to be a sound way of trying to capture productive types of entrepreneurship.

An important stream of literature argues that knowledge spillovers stemming from innovation and entrepreneurship do not only contribute to the competitiveness of firms, but also to that of regions. Concepts like innovative milieux, technological districts, regional innovation systems, learning regions, etc., have been introduced to underline the importance of regions as key drivers of innovation (Camagni, 1991; Storper, 1992; Asheim, 1996; Cooke, 2001). This body of literature refers to success stories like Silicon Valley to stress that key technological advances take place in only a limited number of regions worldwide. Knowledge spillovers also are hypothesized to be one of the main reasons causing localization economies in agglomeration (Henderson 2003).

Many of these studies argue that knowledge spillovers tend to be geographically bounded and that geographical proximity facilitates knowledge sharing and in turn innovation. In addition, this body of literature stresses that all firms in the district benefit from these knowledge spillovers, because they belong to the same social and cultural environment. Numerous case studies have been carried out to provide empirical evidence for these theoretical statements (e.g. Cooke, 2001), while econometric studies also demonstrated that knowledge spillovers are indeed geographically localised (Jaffe et al.1993; Audretsch and Feldman, 1996). In a similar vein, Acs and Plummer (2005) argue that entrepreneurs role of 'filtering' the available knowledge is also a primarily regional phenomenon. Because of the relevance of regional linkages between human capital, innovation and entrepreneurship, it is clear that they should all be considered in the search to explain regional economic development.

Building regional indicators from individual level attributes

The issues above all relate to the question how the drivers of human capital, invention and entrepreneurship – embodied in our empirical application by knowledge workers, inventors and different types of entrepreneurs - are related. We can subdivide this question into two: (i) which – if any - of the three drivers is most important for economic development; and (ii) is there a bottleneck (can regions not develop without one of these). Schumpeter (1934; 1942) seemed to be indecisive about the first question of knowledge drivers considering his emphasis on Mark I (growth through creative destruction- mainly by new and small firms and knowledge less appropriable) and Mark II (growth through innovation in large research labs – mainly big firms that can appropriate knowledge) regimes, respectively. However, the Mark I and Mark II regimes need not be exclusive for regions; they can be seen as complements and the regional industry structure is likely to be conducive to Mark I or Mark II dominance: sectoral patterns are related to the nature of the underlying technological regime (Breschi et al. 2000).

The individual is the most relevant level for studying the entrepreneurial process from opportunity recognition to resource mobilization and exploitation, while recognizing the context this individual operates in. Schumpeter (1947) also asserted that "the inventor produces ideas, the entrepreneurs 'gets things done'". This is a clear call for making distinctions between innovative activity and entrepreneurial activity – and for making these distinctions at the individual level. We argue that indeed individuals should be more promising as a unit of analysis than firms, as it is ultimately individuals who eventually perform the economic activities. Moreover the traditional distinctions between firms, entrepreneurs and employees are increasingly getting blurred in the current Western service-based era of individualism, (social) networking and ICT-developments. The independent entrepreneurs and inventors, forming (temporary) economic coalitions with other independent professionals or(small) firms, have escaped the traditional firm growth path perspective – and our attention thus far (Van den Born 2009). Looking beyond the traditional input factors of labour and capital, regions can outperform in terms of human capital (knowledge workers), innovation (inventors) and creative destruction through business dynamics (entrepreneurs). Accordingly, we take into account that these drivers of competitiveness are conceptually based on individuals – and hence we argue that in empirical exercises at the regional level, measure used should be based on individual-level data.

Cities, transfer mechanisms and place-based development

A regional perspective means taking into account agglomeration economies, and urbanization economies and localization economies in particular. In this paper we focus on both and discuss how the three drivers of growth discussed above can be seen in conjunction with agglomeration. A relatively new insight into modelling entrepreneurship as a driver of regional economic performance is the idea that urban features of a region may have an impact on the magnitude of the measured effect. Not only may levels of entrepreneurship in cities exceed those at the country level (see Acs et al., 2011 for initial evidence on world cities), but also the consequences for economic growth may be higher in cities (see Becker and Henderson, 2000). In particular, Fritsch and Schroeter (2011) find that, for densely-populated areas in Germany, the long-term impact of regional firm-formation rates on employment growth exceeds the impact found for rural areas. Combined with Duranton and Puga's (2004) and Van Oort and Lambooy's (2012) calls for a more explicit treatment of innovation and knowledge spillovers in (micro-founded) economic models, these findings suggest that part of urbanization economies, captured in Ciccone and Hall (1996) and Ciccone (2002) by estimating the impact of employment density on labour productivity, may be accounted for by inventive, innovative and/or entrepreneurial activity.

This may have important implications for regional development strategies, as place-based policies may be appropriate in the European case alongside people-based policies. Barca et al. (2012) summarise the place- and people based policy debate in the European context in detail. Based on current economic geographical theories of innovation and density of skills and human capital in cities and globalisation, spatially blind approaches argue that intervention regardless of the context, is the best way to resolve the old dilemma of whether development should be about "places" or about "people" (Barca et al. 2012, p. 140). It is argued that agglomeration in combination with encouraging people's mobility not only allows individuals to live where they expect to be better off but also increases individual incomes, productivity, knowledge, and aggregate growth (World Bank 2009). Consequently, development intervention should be spaceneutral, and factors should be encouraged to move to where they are most productive. In reality, this is primarily in large cities. In contrast, the place-based approach assumes that the interactions between institutions and geography are critical for development, and many of the clues for development policy lie in these interactions. To understand the likely impacts of a policy, the interactions between institutions and geography, therefore, requires explicit consideration of the specifics of the local and wider regional context (Barca et al. 2012, p.140).

According to place-based development strategists, economic growth is not uniquely related to mega-city regions (Barca et al. 2012). Instead, growth can be distributed across various urban systems in different ways in different countries (OECD 2006, 2011). The place-based approach's emphasis on interactions between institutions and economic geography has allowed for examination of urban development in European cities of all sizes. Because the roles of very large and small communities have been addressed extensively, Barca et al (2012) emphasize the simultaneous role of medium-sized cities, and argue that these are over-represented in Europe.. Many highly productive cities in the EU indeed are small- to medium-sized cities whose dominant competitive advantage is that they exhibit high degrees of connectivity rather than urban or home market scales. A distinguishing dimension in our research period is further the objective-1 versus non-objective-1 regions, as the former are targeted by cohesion policies[1] in the period 2000-2006 that coincide with innovation and entrepreneurship policies. We will put the hypothesis on urban size in relation to growth to a test in the empirical model of this paper.

3. **The model**

The model takes as point of departure that the production in region *i*, situated in country *j* is
driven by the density of production in the region. Following Ciccone (2002), we model a regional productivity function where *q* denotes the output produced on an acre of land (within the region situated in the country), *n* captures employment and k the amount of physical capital. Furthermore *Q* denotes value

[1] The adjective 'objective-1' is specifically associated to European Regional Development Funds (ERDF) in the programming period 2000-2006. ERDF aims to strengthen economic and social cohesion in the European Union by correcting imbalances between its regions, and mainly refers as 'objective-1' to the regions lagging behind in terms of development. The term is region (Europe) and time (2000-2006) specific. In the new programming period, the old 'objective 1' regions together with the Cohesion Fund is understood as 'convergence regions' and considers as well 'objective 2' regions (Dühr et al. 2010, pp. 273-286). In our research period, although objective-1 regions are not the only representatives of cohesion policy regions, they form an important part of it (compare Dogaru et al 2011; Lopez-Rodriguez & Faiña 2006). For regions in Slovenia in our analyses, we used pre-accession funds as indicator. Objective-1 regions can be both urban and rural in character.

added at the regional level and A the acreage of the region in square kilometres. Next to the average level of human capital (*H*) that is also included in Ciccone's analysis, we introduce measures of specialization/diversity (*SD*) which as reciprocal measures sectoral diversity (see below), entrepreneurship (*E*) and invention (*I*).

$$q = \Omega_{ij} f(nH, nE, nI, k; Q_{ij}, A_{ij}) =$$

$$\Omega_{ij}\left[(nH_{ij})^{\beta}(nSD_{ij})^{\gamma}(nE_{ij})^{\delta}(nI_{ij})^{\varepsilon}k^{1-\beta-\gamma-\delta-\varepsilon}\right]^{\alpha}\left(\frac{Q_{ij}}{A_{ij}}\right)^{\frac{(\lambda-1)}{\lambda}} \tag{1}$$

Here Ω_{ij} denotes an index of total productivity in the region. Coefficient α

$(0 < \alpha \leq 1)$

captures returns to physical capital, human capital, entrepreneurs and inventors. The coefficients β, γ, δ and ε are positive and $0 < \beta + \gamma + \delta + \varepsilon \leq 1$. Analogous to Ciccone (2002, p. 216), i.e. assuming that (i) these parameters are equally distributed among the acres in each region; and (ii) the rental price of capital is the same within a country, average regional labour productivity can be derived as:

$$\frac{Q_{ij}}{N_{ij}} = \Lambda_j \Omega_{ij}^{\omega}\left(H_{ij}^{\beta} SD^{\gamma} E_{ij}^{\delta} I_{ij}^{\varepsilon}\right)^{\alpha\lambda\varphi}\left(\frac{N_{ij}}{A_{ij}}\right)^{\theta} \tag{2a}$$

Or alternatively

$$\frac{Q_{ij}}{N_{ij}} = \Lambda_j \Omega_{ij}^{\omega}\left(H_{ij}^{1-\alpha\lambda(1-\beta)} SD_{ij}^{1-\alpha\lambda(1-\gamma)} E_{ij}^{1-\alpha\lambda(1-\delta)} I_{ij}^{1-\alpha\lambda(1-\varepsilon)}\right)^{\varphi}\left(\frac{N_{ij}H_{ij}SD_{ij}E_{ij}I_{ij}}{A_{ij}}\right)^{\theta} \tag{2b}$$

Where Λ_j depends on the rental price of capital in the country (meaning that national differences can be taken into account by including intercepts at the national level), ω is a constant,

$$\theta = \frac{\alpha\lambda - 1}{1 - \alpha\lambda(1-\beta-\gamma-\delta-\varepsilon)} \quad \text{and} \quad \varphi = \frac{1}{1 - \alpha\lambda(1-\beta-\gamma-\delta-\varepsilon)} \tag{3}$$

Coefficient θ therefore measures the effect of the regional density of employment in conjunction with the four other focal indicators on regional productivity: the degree of specialization/diversity and the densities of human capital, invention and entrepreneurship. We will denote this combined effect as the effect of agglomeration economies in the remainder of this paper. In case ($\alpha\lambda = 1$), which for example holds in the special case of constant returns to scale ($\alpha = 1$) in combination with the absence of externalities from the density of production in the region ($\lambda = 1$), the degree of specialization/diversity and the density of employment, human capital, invention and entrepreneurship is irrelevant and productivity is explained by human capital, entrepreneurial activity and innovation independent from the density. In case $\alpha\lambda > 1$, θ is positive and its value will be higher if production is more reliant on physical capital as the assumptions made imply that an increase in total factor productivity – caused by increases in density of employment, human capital, invention or entrepreneurship, will be followed by an inflow of physical capital.

Taking logarithms of (2a), we have:

$$\log Q_{ij} - \log N_{ij} = \log \Lambda_j + \theta(\log N_{ij} - \log A_{ij})$$
$$+ \alpha\lambda\varphi\left[\beta \log(H_{ij}) + \gamma \log(SD_{ij}) + \delta \log(E_{ij}) + \varepsilon \log(I_{ij})\right] + \omega \log \Omega_{ij} \quad , \qquad (4)$$

Which we can rewrite in the form of an estimation equation as follows

$$\log Q_{ij} - \log N_{ij} = \alpha_j + \theta(\log N_{ij} - \log A_{ij})$$
$$+ \eta H_{ij} + \rho SD_{ij} + \kappa E_{ij} + \nu I_{ij} + \mu i_{ij} \quad ; \qquad (5)$$

Where *H, SD, E* and *I* denote respectively human capital, specialization/diversity (often coined localization/urbanization in the literature), entrepreneurship and invention. In Ciccone's computations, the inclusion of regional dummies for different spatial scales did not affect the estimated effect of urbanization economies. These are consistently estimated at a rate ranging between 4.0 and 4.5 percent. In our empirical exercises we only deal with regional and national level, hence the dummies α_j reflect countries.

4. **Data and approach**

Data

The selection of countries and regions included in the empirical study was restricted particularly by data availability on (high) quality types of entrepreneurial activity. These data are based on representative samples among the population between 18-64 years and available for 142 regions across 17 European countries. By eliminating regions in Croatia due to data availability issues for other indicators, as well as the regions with sample sizes lower than 700, we arrive at a sample of 127 regions across 16 European countries (see Bosma 2011) [2]. A second restriction was the availability of the

[2] The initial spatial scale was adopted along a regional classification developed by ESRI, and consisted of 125 regions corresponding to Nuts1 levels for Belgium, France, Germany, Greece, Ireland, the Netherlands, and the United Kingdom. Nuts2 levels are applied to Croatia, Denmark, Finland,

specialization/diversity index. Of the 127 regions for which we had entrepreneurship data, 111 could be assigned the Theil localization-diversity measure over their location quotients (see below).

For analysing equation (5), we require regional-level data on value added, employment, the
acreage of each region, education, the degree of specialization/diversity, invention and types of entrepreneurship that allow to discern innovativeness and growth ambitions. Data on value added and employment are available at the NUTS3 level and are drawn from the Cambridge Econometrics database on European Regions. Data on education are obtained from Eurostat's regional database, which distinguishes three major categories of education. We included the shares of the numbers of people who have tertiary education in 2001 (the denominator is the population aged between 25 and 64). These indicators are available for the NUTS3 regions for all countries except Belgium, Norway and Sweden[3]. The square kilometres for the acreage of the NUTS3 regions are also drawn from Eurostat.

There is a burgeoning literature looking for micro-foundations and causes of agglomeration economies (Rosenthal and Strange 2001, Feser 2002). Whether due to firm size or a large initial number of local firms, a high level of local factor employment may allow the development of external economies within the group of local firms in a sector. These are termed localization economies. The strength of these local externalities is assumed to vary, so that these are stronger in some sectors and weaker in others (Duranton and Puga 2001). The associated economies of scale comprise factors that reduce the average cost of producing outputs in that locality. On the other hand, urbanization economies reflect external economies passed to enterprises as a result from savings from the large-scale operation of the agglomeration or city as a whole, and which are therefore independent from industry structure. Relatively more populous localities, or places more easily accessible to metropolitan areas, are also more likely to house universities, industry research laboratories, trade associations and other knowledge generating institutions. It is the dense presence of these institutions, which are not solely economic in character, but are social, political and cultural in nature, that support the production and absorption of know-how, stimulating

Hungary, Norway, Portugal, Slovenia, and Sweden and a combination of Nuts1 and Nuts2 to Italy, Spain, and Switzerland. In a second step, some dense sub-regions were identified within the previously-identified larger regions; if the sample size allowed, these dense regions are abstracted and treated separately from the larger region of which they form part. This resulted in an augmented sample of 142 regions.

[3] This is no problem for our dataset, as we deal with Nuts2 regions in these countries in our analysis.

innovative behavior and differential rates of interregional growth (Frenken et al 2007). The diverse industry mix in an urbanized locality therefore improves the opportunities to interact, copy and modify practices and innovative behavior in the same or related industries.

The *degree of sectoral specialization and diversity* is an important variable in our models, as it tests our hypothesis on agglomeration. The degree of regional specialization is measured by the Theil index over the location quotients of 59 products including agriculture, manufacturing and services, for the year 2000 (see Thissen et al. 2011 and Dogaru et al. 2011 for a more detailed introduction of this measure). This unique dataset has been collected by the Netherlands Environmental Assessment Agency (PBL) and is based on regionalized production and trade data for 256 European NUTS2 regions, 14 sectors, and 59 product categories (compare Combes & Overman 2004). Location quotients measure the relative specialization of a region in a certain sector as the percentage of production accounted for by a sector in a region relative to the percentage of production accounted for by that sector in Europe as a whole. This quotient measures whether a sector is over- or underrepresented in a region compared with its average representation in a larger area, and therefore is to comprise localization or specialization economies of agglomeration. The Theil coefficient then measures deviations from the European average distribution of production specializations in all sectors. A high score represents a large degree of sectoral specialization in a region, and a low score represents sectoral diversity. Dogaru et al (2011) show that on the level of European NUTS2-regions, the largest national economies of Germany, France and the United Kingdom regions have high levels of sectoral diversity (all regions contain most of the existing sectors, including services). Eastern European regions are relatively specialized, as are Scandinavian, Greek and Irish regions. These regions miss concentrations of certain activities, e.g. specific types of services, manufacturing, distribution or agricultural activities. A group of medium-sized economies, like The Netherlands, Austria, Belgium, Denmark, Italy, Portugal and Spain, show moderate levels of specialization.

Invention is captured by the number of applicants who have filed patents between 2001 and 2006. In endogenous growth theory the generation of new knowledge and innovations is explained by increased investment in R&D (Acs 2002). This was also the perspective of Schumpeter's book of 1942, where he saw the entrepreneurial function of management replacing the risk-taking and innovative individual hero-entrepreneur. In this view it is possible to create a knowledge production function (KPF) with investments in R&D as input and knowledge, in the form of patents as output. Consensus has grown among economists and economic geographers that knowledge production and knowledge spillovers are to an important extent geographically localized (Breschi and Lissoni 2009). To test for knowledge spillovers, most scholars apply a knowledge production function approach to explain the regional production of patents or innovations as a result of public and private R&D inputs and a local spillover index. In more than one case, and for different spatial levels, scholars have been able to indicate that such spillovers turn out to be statistically significant, that is, exert a significant and positive effect on knowledge output as measured by patents or innovations. Geographical proximity is often claimed to be beneficial for successful knowledge exchange. Most often, this is explained by the importance of face-to-face contacts for the exchange of tacit knowledge. In many studies this localized interaction is however only assumed implicitly rather than examined in an explicit manner. It is for this reason that Van Oort and Lambooy (2012) remark that it is not yet clear how the lines of knowledge-generation and application can exactly be connected to producers and consumers in urban contexts. It is particularly necessary to investigate the relative importance of markets (prices) and formal and informal networks as carriers of knowledge. We therefore focus on regionally aggregated inventor-level patents, as that population captures spillover opportunities most optimally. Information on patent activity was derived from the REGPAT database, abstracted from the European Patent Office and cleaned by the KITeS centre based at Bocconi University (Thoma et al. 2010). Applicants include individual applicants, company-based applicants and inventors. The dates of the applications refer to application year (not priority year) as we are interested in the moment that the invention – as an indicator of potential innovation - was introduced to the region.

Our entrepreneurship indicators are derived from the Global Entrepreneurship Monitor (GEM; see Reynolds et al., 2005; Bosma et al. 2012). The indicators are based on telephone surveys among the adult population. A key GEM indicator is the total early-stage entrepreneurial activity (TEA) rate. This measure is defined as the prevalence rate (in the 18–64 population) of individuals who are involved in either nascent entrepreneurship or as an owner-manager in a new firm in existence for up to 42 months. Nascent entrepreneurs are identified as individuals who are, at the moment of the GEM survey, setting up a business. Moreover they have indicated (i) that they have 'done something to help start a new business, such as looking for equipment or a location, organizing a start-up team, working on a business plan, beginning to save money, or any other activity that would

help launch a business'; and (ii) that they will be the single owner or a co-owner of the firm in gestation. Also, they have not paid any salaries, wages or payments in kind (including to themselves) for more than three months; if they have, they are considered to be an owner-manager of a (new) firm.
While the TEA rate is an overall measure of early-stage entrepreneurial activity, identifying different types of TEA is also possible. We draw distinctions between growth expectation (three categories) and innovation orientation. The four types of early-stage entrepreneurial activity are as follows:

1. Early-stage entrepreneurial activity with no growth ambitions TEAGR_NO): Individuals in early-stage entrepreneurial activity who expect to have no or one employee in the next five years
2. Early-stage entrepreneurial activity with some growth expectations (TEAGR_SM): Individuals in early-stage entrepreneurial activity who expect to have 2 or more employees in the next five years
3. Early-stage entrepreneurial activity with high growth expectations (TEAGR_HI): Individuals in early-stage entrepreneurial activity who expect to have 10 or more employees in the next five years
4. Early-stage entrepreneurial activity with innovative ambitions TEAINNOV: Individuals in early-stage entrepreneurial activity who expect (i) at least some customers to consider the product or service new and unfamiliar and (ii) not many businesses offering the same products or services.

In order to get reasonably precise measures at the regional level, GEM data between 2001 and 2006 have been merged, hence the entrepreneurship data in our regression refers to the period 2001-2006. Regional variation in entry rates are often very persistent (Fritsch and Mueller, 2007; Brenner and Fornahl, 2008; Andersson and Koster 2011), as is economic performance (Martin and Sunley, 2006). To see the relevance of identifying *types* of entrepreneurial activity we provide maps relating to three of the types of entrepreneurship in Figures 1-3. The figures point at large differences in regional patterns. The average non-growth regional entrepreneurship rate (TEAGR_NO) pictured in Figure 1 is 2.8 per cent and ranges from 1.2 per cent in the western part of France to 6.0 per cent in Western Transdanubia (Hungary). The rate of high-growth oriented TEA in Figure 2 ranges from 0.6 per cent in the French Parisien Bassin to 2.6 per cent in the Hamburg area. We should note that, since the indicators are estimates rather than count data, there are confidence intervals attached to these estimates. Therefore, when examining the maps one should especially focus on general patterns and not so much on the outcome for one particular region.

[Insert Figures 1-3 about here]

Although we can still figure out national borders in these European maps, regional variations within countries are also large. Focusing on the main differences between lower ambitious types of entrepreneurship (Figure 1) and higher growth ambitious types of entrepreneurship (Figure 2), we see some notable differences. In general, the growth oriented entrepreneurship rates appear to be somewhat higher in or around strongly populated regions. Compared to other European regions, in many Spanish areas there are fairly many early-stage entrepreneurs with low growth expectations, but the rate of ambitious ones with respect to hiring employees is relatively low. The same goes for Northern Portugal, Greece and parts of France. Sweden is an example of a country showing low overall entrepreneurship rates, but performing better on growth oriented entrepreneurship. This is even stronger for the northern part of Italy, where there is relatively little participation in TEA with low growth orientation, but the scores on growth ambitious entrepreneurship are clearly higher. In this respect the Western part of Slovenia connects to Northern Italy. Within France only the Paris and Mediterranean areas have relatively many growth ambitious early-stage entrepreneurs, while this rate is low in all other regions. Regions performing relatively bad in all types of independent entrepreneurship are situated in the East of France, and to a lesser extent, some Swedish regions and the whole of Belgium[4].

The innovation oriented early-stage entrepreneurship rates (Figure 3) show an even larger regional variation. In the UK, the London area and the Eastern region (including Cambridge) outperform other regions with respect to innovation oriented early-stage entrepreneurship rates. The Mediterranean area (including Nice/Sophia-Antipolis) seems to be rather innovative, as compared to the rest of France; Emilia-Romagna and Sardinia show far higher innovative entrepreneurship rates than Sicily. Sweden and Finland show high levels of innovation oriented entrepreneurial activity; while especially in the latter country regional variation is also large.

Table 1 shows the means, standard deviations and correlations of all the variables concerned in the estimation of equation (2). The average value of our dependent

[4] We would like to point out that the entrepreneurship measure in our analysis disregard entrepreneurial activity conducted by employees. In Bosma et al (2012), in a first international comparison of entrepreneurial employee activity, countries like Sweden, Belgium and France appear to exhibnit relatively high levels of entrepreneurial employee activity.

variable, regional labour productivity, equals 3.88. Further inspection reveals that there are substantial differences between countries (more so than within countries). The standard deviation between countries equals 0.45, whereas the standard deviation within countries equals 0.13. This result confirms that country borders need to be appreciated in our empirical models explaining labour productivity. Still, regional differences are important as the top performing regions are situated in different countries: highest labour productivity rates are found in Oslo and surroundings, the Western parts of Switzerland, Ile de France (Paris), Stockholm area and Copenhagen area. Many urbanised areas feature in the top 15 regions in terms of labour productivity. The bottom 15 consists of regions in Hungary, Portugal, Slovenia and Extremadura (Spain).

Table 1 further indicates that high regional education levels, patenting activity, high-growth-oriented entrepreneurship and innovation-oriented entrepreneurship are all positively correlated with regional levels of labour productivity while low growth-oriented entrepreneurship correlates negatively with labour productivity. Also, high-growth-oriented entrepreneurship correlates positively with employment density. The correlation between high-growth-oriented entrepreneurship and innovation-oriented entrepreneurship equals 0.61, which could potentially lead to multicollinearity problems in case they are both included in a model. We have therefore decided to not include two entrepreneurship measures in the same regression. Employment density is strongly correlated with its instrumental variable, the acreage of the region. The instrument is not correlated with labour productivity and therefore this assumption for proper instruments is not violated[5]. We also calculated the correlations with overall regional TEA rates. Interestingly, it turned out these overall rates did not correlate significantly with any of the three different types of TEA listed in Table 1. This finding confirms the relevance of identifying different types; their regional patterns turn out to differ from each other.

We finally observe that although innovation oriented entrepreneurial activity and innovation through patent activity are positively linked, the relation is rather weak. In addition, there seems to be no clear pattern for these measures in relation to employment density. We should note that these findings may turn out to be different if we would use a different spatial classification. For instance, if the Cambridge and Oxford region could be abstracted from the South-East (England) region that we employ as observation in our analysis, employment density and

[5] There is also no significant correlation between the error terms resulting from our regression and the acreage of the region.

patenting activity would probably both be high in this particular area. Both measures would be lower for the remainder of the South-East region.

Approach

Having described our data and revealed some initial statistical associations, we now turn to the steps in our regression analysis. The first step consists of an analysis reminiscent to that of Ciccone (2002), although not all variables of that analysis can be reproduced exactly and the period of analysis is much more recent. The main reason for building so closely on this previous work is to see whether the spatial application we adopt in this paper makes a difference for the analysis: we change to such a spatial scale of analysis that allows us to include measures of (types of) entrepreneurship and the measure of specialization/diversity. Next, we add the index measuring specialization/diversity in order to appreciate agglomeration economies as a combination of urbanization economies and localization economies. In a third step we add our measures of entrepreneurship and invention and see (i) whether accounting for entrepreneurship and patenting activity provides for an additional explanation of regional differentials in productivity levels; and (ii) what this means for the estimated effect of 'urbanization economies' as explained in the previous section. Finally, we introduce spatial regimes in our 2SLS models allowing for coefficients to structurally differ over objective-1 versus non-objective-1 regions (based on Dogaru et al. 2011 and Lopez-Rodriguez and Faiña 2006) and over large (at least 3 million inhabitants), medium-sized (between 1.5 and 3 million inhabitants) and small (lower than 1.5 million inhabitants) regions[6]. The next section is structured based on these three steps in our analysis.

5. Results

The initial model

The first model in Table 2 is largely in vein of the model introduced by Ciccone (2002) with country dummies and employment density instrumented with the acreage of the region. For 1989, Ciccone reported a coefficient for employment density equal to 0.046 with a robust standard error of 0.005. Whether NUTS0 (country), NUTS1 or NUTS2 regions as fixed effects were included did not make any significant difference in the estimated size of this coefficient. Our analysis of the effects on labour productivity in 2006 in model 1 yields very similar results, although we arrive at a somewhat higher coefficient (equal to 0.053).

[6] Although this distinction differs somewhat from that in OECD (2012), these cut-off points yield a distribution for the European regional classification adopted in the paper that is comparable to the OECD-distribution on a global scale.

Augmenting the number of countries and adopting the regional level for which we have data on patenting and entrepreneurship leads to a decrease in the number of observations. For these 127 regions over 17 countries, the estimated effect in model 2 decreases somewhat to 3.9 percent (model 2a) and is significant at the 5 percent level. In this different spatial setting, the coefficient measuring the effect of education is now positive and significant. The standard errors are somewhat larger owing to the lower number of observations. Model 2b shows the results of the very same model, however limited to the observations for which the specialization/diversity measure is also available. Model 2c then shows the estimates including the specialization/diversity measure, leading to an estimated coefficient to employment density of 4.3 percent, very similar to the Ciccone (2002) findings[7].

Hausman tests indicate that random effects estimation may not be used with model 1b but they may be used with models 2. Estimating with random effects appeared to better explain variations between countries, but not within countries. As we are primarily interested in capturing regional effects, we proceeded with fixed effects estimations - also to be consistent with Ciccone (2002)[8]. In addition, tests revealed that there are no indications of the necessity of spatial autocorrelation model corrections[9].

Adding agglomeration economies

As noted, model 2c reveals that the specialization/diversity measure that is hypothesized to capture sector-specific agglomeration economies has no effect on productivity when looking at their direct effect in isolation. Employment density as the second indicator of agglomeration is positively significant in all models in Table 2. On the basis of these results, one would conclude that specialization and/or diversity effects (as measured in the Theil index) do not matter for productivity, and have no added value on top of urbanization per se (as measured by employment density). This confirms the signaled ambiguity of empirical studies on specialization and diversity in relation to productivity and growth: no dominant force of either one of them is found. When including innovation and entrepreneurship variables in model 3, the relation of agglomeration indicators

[7] Even though the coefficient for the specialization/diversity measure is not significant its addition to model 2b leads to a better model fit ($p<.05$).

[8] Auxiliary regressions (not reported) indicate very similar outcomes for Tables 2 and 3 when applying random effects estimation.

[9] Using a binary weight matrix with information on neighbouring regions, the Getis-Ord statistics did not point at spatial lags for the dependent and independent variables, nor for the residuals. In contrast to the more often used Moran's I statistic, the Getis-Ord statistic focuses on clustering of high and low values (Getis and Ord 1992), which would be the relevant issue of concern in our analysis.

with productivity changes. Again, the employment density indicator is always positively significant attached to productivity. But now also, in models 3a, 3f and 3g that all include the patenting variable, the level of (aggregate) specialization is positively related to productivity and has an additional effect over the density variable. The model fit improves considerably. The indicators for innovation (patenting) and entrepreneurship are positively and significant attached to productivity as well.

Adding entrepreneurship and invention as knowledge transfer mechanisms
Introducing variables that capture knowledge transfer mechanisms much more closely instead of aggregate agglomeration variables in isolation, changes the picture and leads to more interpretable results. The effect of agglomeration economies is captured by a complex interplay of the variables density, specialization, entrepreneurship and innovation. Initial models only focusing on some of these dimensions in isolation miss important effects that are revealed in our analysis. This confirms our plea for conceptualizing and empirically measuring agglomeration variables that capture spillovers and externalities as close as possible.

The first model in Table 3 repeats the results of model 2c for the sake of comparison. Model 3a adds invention (measured by patenting activity) and we observe that this coefficient is positive and highly significant ($p<0.01$). From the results in models 3b-3d, entrepreneurial activity also appears to be a positive contributor and significant at $p<0.10$. This holds for all four distinguished types of entrepreneurship, while we particularly expected the impact to be positive for high-growth and for innovation-oriented entrepreneurial activity. Our expectations are however, confirmed in the sense that the regional variations in labour productivity are best explained by patent activity as well as growth and innovation-oriented entrepreneurship. A possible explanation of the positive and weakly significant effect of low growth- oriented entrepreneurial activity may be that we pick up some of the effects not captured by employment and education. Self-employment is not very often captured in employment statistics used to estimate growth models. Put differently, the effect found for low-ambition self-employment may be very similar to the traditional effect of employment. The model fit statistics suggest that focusing on low-ambition self-employment as a measure of entrepreneurship particularly leads to poorer explanation of productivity differentials between countries.

Interestingly, we find distinctive results for patenting activity and the measure of some growth-oriented entrepreneurship. These types exhibits the strongest interplay with employment density controlling for national effects- since the estimated 'urbanization economies' effect drops from 4.3 percent (and statistically significant at $p<.05$) in model 2c to 2.9 percent and 3.4 percent (statistically insignificant at $p<.10$) in models 3a and 3d respectively. Thus, acknowledging the effect of employment density and human capital alone may not give a sufficient picture of economic advantages to urbanisation; regions also require people with new ideas (innovation) and/or entrepreneurs who can create employment opportunities – the existence of social capital may reinforce the occurrence of such entrepreneurs, see for example Bosma et al. (2004). Accounting for the three drivers of economic growth considered in our study (human capital, inventors and entrepreneurs), the importance of the density of employment in conjunction with these drivers for regional productivity appears to be limited at best. Adding entrepreneurship and patenting activity to model 2c does lead to a significant improvement for most of the models: a likelihood ratio test supports the relevance of the inclusion of early-stage entrepreneurial activity at $p<0.05$ for models 3a-3c and at $p<0.1$ for models 3d and 3e. In models 3f and 3g we allow for separate effects of innovation (from patent activity) and entrepreneurial activity. Results from both models suggest complementarities rather than substitutes: sizes and significances are only slightly lower in comparison to those in models 3a, 3c and 3e and the effects remain positive and significant, whereas the model fit improves that of 3a ($p<0.05$ for model 3f and $p<0.10$ for model 3g).

[Insert Table 3 about here]

Spatial regime analyses

Table 4 presents 2SLS estimates of a model of productivity where the sample of 111 regions is split in two regimes (regions that obtained objective-1 funds in the research period versus those that did not) and three regimes (large-medium-sized and small urban regions) respectively. In the models in table 4 all entrepreneurship variables are introduced[10]. Regime analysis estimates the two equations simultaneously, and performs a spatial Chow-Wald test to determine the significance of the regime. Because much of region-specific heterogeneity is now captured by the respective regimes, no spatial fixed effects are introduced in the model. The spatial Chow-Wald test for the productivity equation shows that the two regimes concerning objective-1 funds significantly differ from each other, while those on size do not. Coefficients that significantly differ over regimes

[10] The correlations between these variables is not very high (and never higher than 0.61).

(tested by t-tests) are boxed in Table 4). Non-objective-1 regions contain a significant relation of high growth aspiration entrepreneurship with productivity, a larger impact of the absence of entrepreneurs without growth aspirations, and a larger impact of education. Interestingly, although the coefficients over the urban size regimes do not significantly differ from each other in direction, they do differ in magnitude. In large urban regions entrepreneurs with a mediate level of growth aspiration are more (and significantly) attached to productivity, while in medium-sized urban regions innovative entrepreneurs are significantly contributing to productivity. The explained variance is in both regime-analyses considerable higher than in the non-regime analyses, suggesting that the regimes capture an additional part of the regional variation in productivity. The share of higher education remains important in all regimes except for the small urban regions, and patent activity is an important contributor to productivity in the largest as well as medium-sized urban regions. The regime analyses suggest that spatial heterogeneity is a crucial issue in explaining productivity patterns. Besides large urban regions, medium-sized regions are indicative for explaining productivity by (innovative) entrepreneurial activity. This suggests that a focus on particular types of regions (large, medium-sized, or objective-1 regions) can also direct policymakers in place-based development strategies.

6. Conclusions and discussion

In this paper we posited that for the discussion on the merits of agglomeration economies it is vital to acknowledge the underlying knowledge spillover circumstances of innovation and entrepreneurship. We considered externalities related to innovation and entrepreneurship as an explanation of regional differences of economic performance in a specific spatial and economic context. We concentrated on the occurrences of specific types of entrepreneurship in the early-stage phase, when the venture is in the exploration phase (nascent entrepreneurship) or in the early years after the start-up. The types of early-stage entrepreneurship –innovation oriented entrepreneurial activity and measures related to growth expectation entrepreneurial activity - are determined at the individual level, and their regional prevalence rates exhibit significant variation. Similarly we looked at individuals filing patents at the EPO for retrieving measures of patent activity, possibly leading to innovation. A first inspection of the data showed that, although positive relationships exists between levels of growth- and innovation-oriented entrepreneurship and patent activity, the regional patterns are essentially different. Hence, innovative activity through patenting, entrepreneurship that exploits innovations and entrepreneurship that is growth-oriented in general measure different aspects of the creative destruction mechanism. Besides our interest in the empirical relationship between productivity, entrepreneurship and innovation in European regions, we were interested in opportunities for place-based development (as opposed to people-based or place-neutral development), as recently advocated by the European Union. Given our regional data that was built-up from the individual level (of entrepreneurship and patenting data) and recent delineations on urban size and cohesiveness, we are able to test the proposition that medium-sized urban regions, besides larger or small communities, or so-called objective-1 hold good cards for regional development.

In our empirical investigation we found confirmation for the importance of both types of early-stage entrepreneurship and patenting activity in explaining regional variation in labour productivity. Moreover, we found in our analysis of European regions that the impact of growth-oriented entrepreneurship and patenting activity is complementary to an important part of the urbanization economies effects, as found by for instance Ciccone (2002), who also examined European regions. Thus, urbanization economies can partly be explained by the effect of differentials in regional levels of growth oriented entrepreneurship and patent activity. We did not find this particular effect for innovation oriented entrepreneurship or entrepreneurs who do not expect to grow.

An interesting finding was also that regions with high levels of low-growth-oriented entrepreneurship (that is, early-stage entrepreneurs expecting to generate at most one job apart from their own over the next five years) were also associated with higher levels of labour productivity. Regions with a large number of such early-stage entrepreneurs, overall constituting over 50 percent of all early-stage entrepreneurs, may be more productive because there are more people who are responsible for their own income and therefore willing to work hard. In addition, these findings may reflect productivity gains stemming from the trend of increasing ‘independent professionals’ in services sectors. Many of these entrepreneurs are focused on increasing their earnings, basically under the condition that they will not grow in terms of employment. As a result, many of these independent professionals subcontract and, as a regional aggregate, their impact may be sizable in terms of regional productivity measures. Another explanation may be that the effect of low-growth entrepreneurship adds to the effect of labour, since in most statistics the number of employed exclude the self-employed. In this perspective, the positive effect found with low-growth-oriented entrepreneurship may be interpreted similarly to the contribution of the traditional factor of labour.

Our finding in specially conducted regime-analyses relates to the second aim of this paper, which is to contribute empirically to the recent discussion on place-based or place-neutral development strategies in the European Union (Barca et al. 2012). A conceptual development discussion burgeons between, on the one hand, spatially blind approaches that argue that intervention regardless of context ("people-based policy") is the best way to go forward and, on the other hand, place-based approaches that assume that interactions between institutions and geography are critical for development. This idea has recently been translated into either a focus on the largest urban concentrations ("people-based policies") or on an urban network setting combining clusters of especially medium-sized cities ("place-based policies"). Our framework combining productivity, entrepreneurship and invention shows that although the spatial regimes of urban regional size are not significantly different from each other, there are still indicative differences in the qualitative entrepreneurship-productivity relation. Innovative entrepreneurship is positively attached to productivity only in medium-sized urban regions, while mediate growth oriented entrepreneurship is more attached to productivity in large urban regions. Also the distinction in regions based on objective-1 funding is important, with better performance opportunities (still) to be found outside cohesion regions. This regional heterogeneity suggests that micro-economic processes work out differently in different regions, thereby supporting European place-based policy strategies alongside place-neutral (people-based) policy strategies. Furthermore, growth- and innovation oriented entrepreneurship are particularly individually driven phenomena, and could be constrained by e.g. national levels of employment protection as Bosma et al. (2009) found. Their analysis also suggested that urbanization has an indirect impact on entrepreneurship via individual level variables such as age, education and the degree to which people see entrepreneurial examples (a form of entrepreneurship-specific social capital). These circular relationships underline the long-lasting trend towards more urbanisation (United Nations, 2007).

Finally, our approach using information at the individual level and the firm level to create measures at the regional level - opens other avenues for further multilevel research. To some extent, we accounted for the interaction between human capital and growth-oriented entrepreneurship when we investigated the impact on urbanization economies, but this could be modelled more explicitly. Such models can then also control for endogeneity issues arising from the omission of such interactions in so-called intangible regional assets (Artis et al 2012). For instance, the data would also allow examining the impact of highly-educated entrepreneurs on regional performance viz. a viz. the impact by lower educated entrepreneurs. Similarly, one could include more quality aspects in the invention measures by also considering patent citations. Our results do point at separate positive effects of innovation and entrepreneurship, however contingent on characteristics of the regional environment. Therefore, Schumpeter's (1947) claim that "the inventor produces ideas, the entrepreneur 'gets things done'" could be aligned with the existence of spatially bounded spillover effects.

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Table 1 Descriptive statistics, regional level, N=111

	Mean	Std. Dev	Correlation table 1.	2.	3.	4.	5.	6.	7.	8.
1. Labour productivity 2006 (ln)	3.88	0.39								
2. Employment density 2001-2006 (ln)	-2.57	1.44	0.31*							
3. Acreage of the region (*1000)	27.0	30.5	0.04	-0.68*						
4. Specialization (Theil), 2000	0.073	0.049	0.02	-0.45*	0.25*					
5. Patent activity, total, (*1000), 2001-2006	0.37	0.34	0.56*	0.26*	-0.08	-0.14				
6. Entrepreneurship: low growth, 2001-2006	2.78	0.84	-0.30*	0.10	-0.16	-0.04	-0.03			
7. Entrepreneurship: high growth, 2001-2006	0.73	0.44	0.31*	0.51*	-0.38*	-0.17	0.29*	0.37*		
8. Entrepreneurship: innovation, 2001-2006	0.91	0.46	0.44*	0.26*	-0.05	0.02	0.25*	0.30*	0.61*	
9. Share tertiary education, 2003 (ln)	-2.25	0.46	0.58*	0.33*	-0.08	017	0.44*	0.04	0.31*	0.38*

* p <0.01

Table 2 2SLS estimation results with different spatial settings and estimation techniques. Dependent variable: regional levels of labour productivity, 2006, in logarithm

	Model 1	Model 2a	Model 2b	Model 2c
Employment density (ln), Average 2001-2006	0.053*** (0.008)	0.039** (0.020)	0.034* (0.019)	0.043** (0.019)
Specialization-diversity, 2000				0.87 (0.56)
Share tertiary education (ln), 2001	-0.02 (0.03)	0.29*** (0.09)	0.19** (0.08)	0.18** (0.08)
Constant	3.92*** (0.05)	4.63*** (0.10)	4.38*** (0.15)	4.32*** (0.15)
Nr. of countries	5	17	14	14
Nr. of regions	766	127	111	111
Regional classification	NUTS3	NUTS1/3	NUTS1/3	NUTS1/3
Treatment country effects				
Fixed effects	yes	yes	yes	yes
Hausman test X^2	71.44 (p<0.01)	1.29 (p=0.52)	2.01 (p=0.37)	5.02 (p=0.17)
R-squared overall	0.189	0.313	0.336	0.313
Within countries	0.164	0.457	0.343	0.375
Between countries	0.473	0.274	0.342	0.312

* p <0.10, ** p<0.05, *** p<0.01
Note: Acreage of the region enters the regressions as instrumental variable for employment density.

Table 3 2SLS estimation results including measures of types of entrepreneurship. Dependent variable: regional levels of labour productivity, 2006, in logarithm

	Model 2c (repeated)	Model 3a	Model 3b	Model 3c	Model 3d	Model 3e	Model 3f	Model 3g
Employment density 2001-2006	0.043**	0.029	0.044**	0.038*	0.034	0.043**	0.025	0.030
	(0.019)	(0.019)	(0.019)	(0.021)	(0.021)	(0.019)	(0.020)	(0.019)
Specialization-diversity Index, 2000	0.87	1.27**	0.80	0.72	0.75	0.66	1.11**	1.04*
	(0.56)	(0.53)	(0.56)	(0.56)	(0.57)	(0.58)	(0.53)	(0.54)
Share tertiary education, 2001	0.18**	0.20***	0.17**	0.16**	0.16**	0.16**	0.18**	0.18**
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.07)	(0.07)
Patenting activity, 2001-2006		0.17***					0.16***	0.17**
		(0.04)					(0.04)	(0.04)
Entrepreneurship, 2001-2006								
- No growth aspiration TEA			0.031*					
			(0.016)					
- Some growth aspiration TEA				0.043**			0.037**	
				(0.018)			(0.017)	
- High growth aspiration TEA					0.085*			
					(0.044)			
- Innovation TEA						0.066*		0.065*
						(0.037)		(0.035)
Constant	4.32***	4.24***	4.22***	4.17***	4.20***	4.24***	4.11***	4.17***
	(0.15)	(0.14)	(0.15)	(0.15)	(0.15)	(0.14)	(0.14)	(0.13)
Nr. of countries	14	14	14	14	14	14	14	14
Nr. of regions	111	111	111	111	111	111	111	111
Regional classification	NUTS1/3	NUTS1/3	NUTS1/3	NUTS1/3	NUTS1/3	Nuts1/3	NUTS1/3	NUTS1/3
R-squared overall	0.313	0.407	0.224	0.319	0.320	0.361	0.431	0.454
Within countries	0.375	0.453	0.400	0.405	0.393	0.400	0.476	0.489
Between countries	0.312	0.436	0.167	0.319	0.320	0.372	0.451	0.454

* p <0.10, ** p<0.05, *** p<0.01

Notes: Fixed effects (country level) used in all models. Standard errors reported between parentheses. Regions with a GEM sample size lower than 700 have been excluded (15 regions). Employment density instrumented with acreage of the region.

Table 4 2SLS estimation results by objective-1 and urban size regimes. Dependent variable: regional levels of labour productivity, 2006, in logarithm

	Model 4			Model 5	
	Objective-1	Non-obj.-1	Small	Medium	Large
Employment density 2001-2006	0.016	0.097	-0.060	0.052	-0.007
	(0.04)	(0,06)	(0.08)	(0.06)	(0.06)
Specialization-diversity Index, 2000	0.887	-0,225	-1.180	0.890	0.230
	(1.02)	(0.95)	(1.61)	(0.73)	(1.60)
Share tertiary education, 2001	0.221***	0.325***	0.269	0.289**	0.510***
	(0.10)	(0.14)	(0.18)	(0.16)	(0.17)
Patenting activity, 2001-2006	0.100	0,432	0.135	0,339***	0.465**
	(0.09)	(0,326)	(0.14)	(0,12)	(0.26)
Entrepreneurship, 2001-2006					
- No growth aspiration TEA	0,032	-0.218***	-0.189***	-0,183***	-0.214***
	(0,53)	(0.040)	(0.059)	(0,07)	(0.050)
- Some growth aspiration TEA	-0,542	0,113*	0.028	0,093	0.144***
	(0,44)	(0,07)	(0.09)	(0,08)	(0.06)
- High growth aspiration TEA	0,049	0,247**	0.249	0,016	-0.078
	(0,11)	(0,13)	(0.17)	(0,17)	(0.17)
- Innovation TEA	0,449	0,107	0.218	0.241**	0.123
	(0,84)	(0,15)	(0.19)	(0.13)	(0.127)
Constant	4.467***	4.206***	4.49***	4.604***	4.98***
	(0.26)	(0.15)	(0.38)	(0.36)	(0.55)
Nr. of countries	14			14	
Nr. of regions	111			111	
Regional classification	NUTS1/3			NUTS1/3	
R-squared overall	0.786			0.726	
Spatial Chow-Wald test (prob.)	41.414			17.979	
	(0,000)			(0.457)	

* p <0.10, ** p<0.05, *** p<0.01

Notes: Fixed effects (country level) used in all models. Standard errors reported between parentheses. Regions with a GEM sample size lower than 700 have been excluded (15 regions). Employment density instrumented with acreage of the region. Coefficients that significantly differ over regimes are boxed.

Figure 1 Total early-stage entrepreneurial activity (TEA) with low growth orientation (zero or one employee in the next five years), percentage of population between 18-64 years, 2001-2006

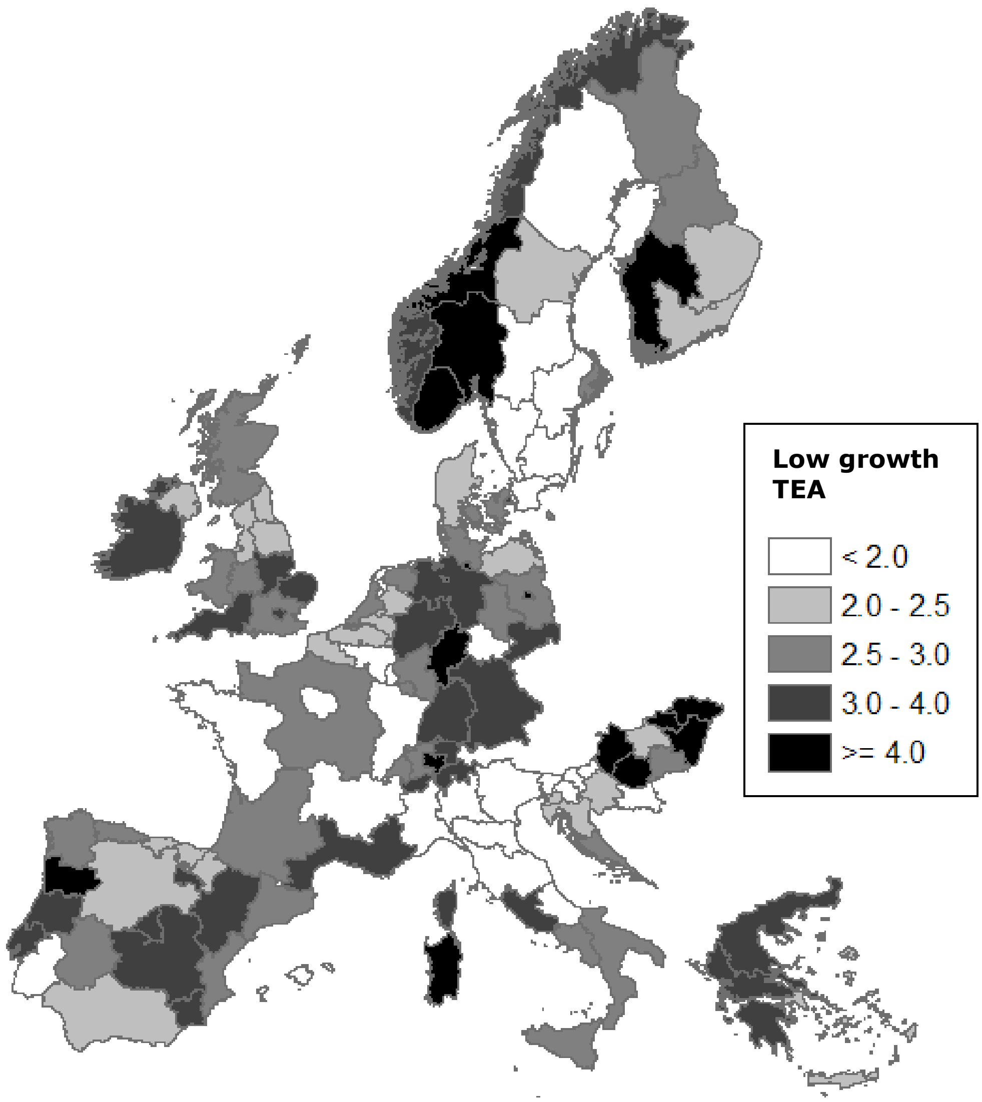


Figure 2 Total early-stage entrepreneurial activity (TEA) with high growth orientation (ten or one more employees in the next five years), percentage of population between 18-64 years, 2001-2006

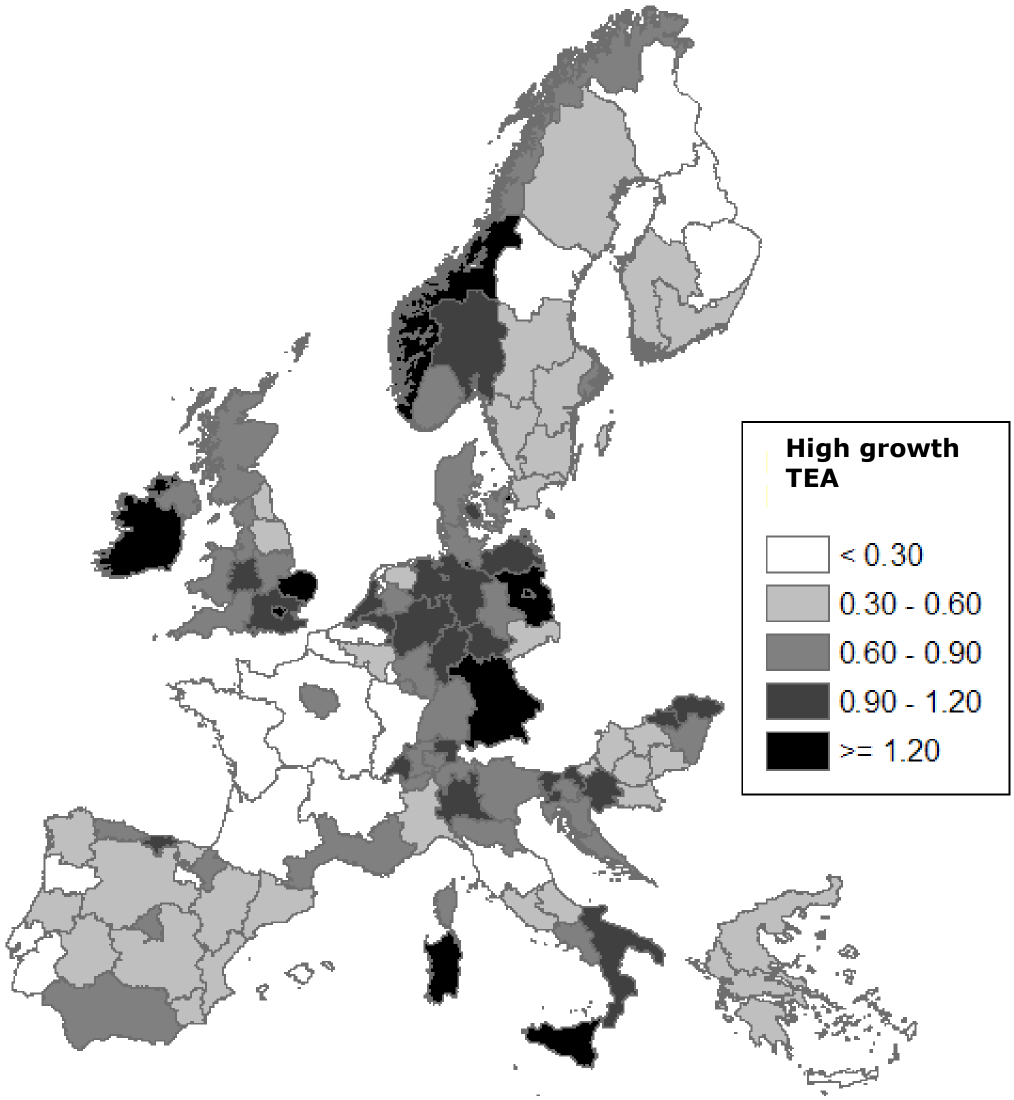
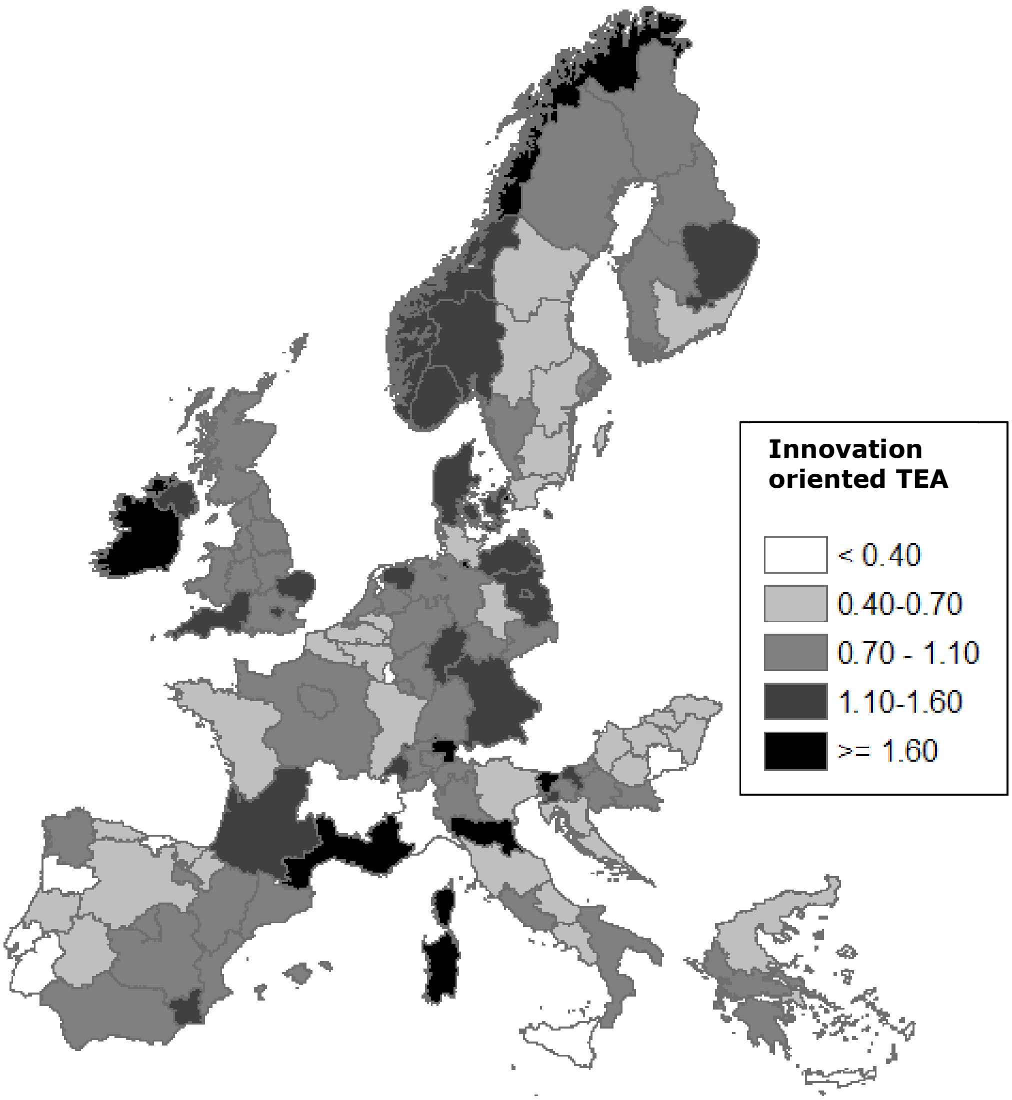


Figure 3 Total early-stage entrepreneurial activity (TEA) with innovative orientation (regardless of sector), percentage of population between 18-64 years, 2001-2006



Appendix: Regions included in the empirical analysis

Belgium (NUTS1)
Brussel
Vlaams Gewest
Region Wallone
+ Antwerp (NUTS2)
+ Ghent (NUTS2)

Denmark (NUTS2)
Copenhagen area
Sealand and Bornholm
Funen
Jutland
+ Aarhus area (NUTS3)

Finland (NUTS2)
Ita-Suomi
Etela-Suomi
+ Helsinki Area (NUTS3)
Lansi-Suomi
Pohjois-Suomi

France (NUTS1)
Ile de France
Parisien Bassin
East
West
South-West
Center-East
Meditéranee

Germany (NUTS1)
Baden-Württemberg
+ Stuttgart (ROR)
Bayern
+ München (ROR)
Berlin
Brandenburg
Hamburg
Hessen
+ Rhein-Main (ROR)
Mecklenburg-Vorpommern
Niedersachsen
Nordrhein-Westfalen
+ Duisburg-Essen (ROR)
+ Düsseldorf (ROR)
+ Köln (ROR)
Rheinland - Pfalz
Sachsen
Sachsen-Anhalt
Schleswig-Holstein
Thüringen

Greece (NUTS2-3)
Athens
Macedonia & Thrace

Greece (NUTS2/3) cont'd
Macedonia & Thrace
Thessaly & Epiros
Central + Ionian Islands
Peloponnesus /Aegean/Crete

Hungary (NUTS2)
Central Transdanubia
Western Transdanubia
Southern Transdanubia
Northern Hungary
Northern Great Plain
Southern Great Plain
+ Budapest area (NUTS3)

Ireland (NUTS2)
Dublin
Border, Midl., Western
Southern and Eastern

Italy (NUTS1-2)
Nord-Ovest
Lombardia
Nord-Est
Centro
Campania
Sud
Sicilia

Netherlands (NUTS1)
Noord-Nederland
Oost-Nederland
West-Nederland
+ Utrecht (NUTS3)
+ Amsterdam (NUTS3)
+ The Hague (NUTS3)
+ Rotterdam (NUTS3)
Zuid-Nederland

Norway (~NUTS2)
North Norway
Middle Norway
West Norway
South Norway
Oslo and surroundings

Portugal (NUTS1)
Norte (incl Porto)
Centro
Lisboa e Vale de Tejo

Slovenia (NUTS2-3)
Kraska
Dolenjska, Osrednjeslovenska, Zasavska

Slovenia (NUTS2/3) cont'd
Koroska, Savinjska, Spodnjeposavska
Pomurska and Podravska

Spain (NUTS2)
Galicia
Asturias
Pais vasco
Navarra
Aragon
Madrid
Castilla y León
Castilla La Mancha
Extremadura
Catalunya
+ Barcelona (NUTS3)
Comm Valenciana
Baleares
Andalucia
+ Valencia (NUTS3)
+ Sevilla (NUTS3)
+ Malaga (NUTS3)
Murcia
Canarias

Sweden (NUTS2)
Stockholm area
Östra Mellansverige
Sydsverige
Norra Mellansverige
Mellersta Norrland
Övre Norrland
Småland med öarna
Västsverige

Switzerland (~NUTS1/2)
North-East
North-West
South
West (French speaking)

United Kingdom (NUTS1)
Scotland
North East
North West
Yorkshire Humberside
East Midlands
West Midlands
East Anglia
Greater London
South East
South West
Wales
Northern Ireland

Note: This list only includes the regions with GEM sample sizes higher than 700 observations. Regions in Norway, Slovenia and Switzerland are not included in model 2b and beyond.
+ Urban area has been abstracted from larger surrounding areas (these abstracted areas are not visualized in Figures 1-3).
ROR: 'Raumordnungsregionen'. This classification for German regions indicates labour market areas; its spatial scale lies between the European NUTS2 and NUTS3 classification.