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Abstract

This thesis consists of an introductory chapter and four individual papers. In each paper the relationship between some form of spatial diversity and economic performance is analyzed. Diversity is treated as a potential source of externality effects, mainly in the form of knowledge spillovers.

The first paper studies the impact of a broad range of spatial externalities on the productivity of manufacturing plants. While finding positive effects of specialization and competition, there is no support for positive spillovers of either related or unrelated industry diversity. The second paper argues that relatedness should be framed at the level of individuals and consequently should be measured in terms of, for example, education and occupation rather than industry belonging. The results show that educational- and occupational-related diversity matter for regional productivity growth, while related industry diversity is positively related to employment growth.

The third paper analyzes the importance of neighborhood related diversity, in terms of both industries and education, and internal human capital for firms’ propensity to innovate. The findings support that education and skills are strongly related to firm innovation. Additionally, firms in metropolitan regions are more innovative in neighborhoods with more related diversity in industries, while firms in rural regions seem to benefit more from related diversity in education. In the fourth paper, the location factor of interest is segregation, which may be regarded as inverse diversity. The results show that neighborhood segregation has a negative effect on individual employment. However, it is not the spatial separation of individuals with different backgrounds that causes lower employment but rather the distress of segregated neighborhoods.
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Introduction and Summary of the Thesis

1 Introduction

“...regional or "spatial" economics might be summed up in the question “What is where, and why — and so what?””

Economic performance is commonly at center stage in both policy- and research discussions on issues related to the development of countries, cities, and regions. Following the early model of Solow (1956), economic performance, in terms of growth, has been the subject of both theoretical and empirical research for many decades. Economic growth theories indicate that factors such as productivity, employment, and innovation are important mechanisms to explain in order to understand why some places grow faster than others. Jacobs (1969), in her historical account of cities, argues that the main driver of economic development is urban diversity. There is simply a greater flow of new ideas in dense and diverse environments, which increases the probability that firms absorb and exploit new knowledge, that they learn from innovations in other lines of work, and that new firms doing new things are started. The existence and growth of cities can thus be explained by agglomeration economies, that is, the benefits that result from firms and people being located in close proximity to each other.

In order to understand how these benefits come about, Duranton and Puga (2004) identify three mechanisms behind agglomeration economies; greater opportunities for i) matching on the labor market, ii) sharing of indivisible facilities, input suppliers, and risk, and iii) learning due to the faster generation, diffusion, and accumulation of knowledge. These mechanisms help to explain why the clustering of economic activity promotes economic performance. They also follow naturally from the framework of Marshall (1890), who can be regarded as the founding father of the literature on agglomeration economies. Despite commonly being regarded as a strong advocator of industry specialization, Marshall (1890) recognizes that specialization may be detrimental for small industrial districts due to the lack

1 Hoover and Giarratani (1985, p.4).
of variety in employment opportunities, as well as sensitivity to economic shocks. He also acknowledges the role of variety in, for example, entrepreneurial and innovative activities, as well as in consumer tastes. In later works, Marshall (1919) argues that cooperation between firms is most efficient in larger places with a variety of specialized industry branches. Variety, or diversity, is also highlighted by Duranton and Puga (2004), who conclude that heterogeneity of firms and individuals is at center stage in all three mechanisms of agglomeration economies.

Diversity is also at the core of this thesis. In each paper, diversity is connected to economic performance of regions, firms, or individuals, in terms of productivity, employment, growth, or innovation. As can be noted from above, the theoretical relationship between regional diversity and economic performance is rather well-established. Following the seminal works of Glaeser et al. (1992) and Henderson et al. (1995), the empirical relationship between industry diversity and growth has been tested rigorously, although with rather inconclusive results. What distinguishes this thesis from previous work is that a broad definition of diversity is employed, including the perspective of individuals and their specific characteristics, skills, and abilities. By doing so, it can be argued that the measures of diversity applied here come closer to Jacobs’ understanding of diversity, who indeed has a broader view than industry or product variety. Jacobs’ thriving cities are dense and well-planned places high on economic, social, cultural, political, and architectural diversity (Jacobs, 1961;1969). The intuition behind the focus on individuals is also that knowledge spillovers are facilitated by human interaction, since knowledge is shared between actual people rather than firms per se. This is important from both a research and a policy perspective, particularly in discussions and assessments of local and regional diversity, such as smart specialization strategies2 (cf. McCann and Ortega-Argilés, 2015).

It may be argued that due to reductions in transport costs, as well as advances in information and communication technology (ICT), geographical proximity, or spatial agglomeration is becoming less relevant as a facilitator of knowledge externalities. Indeed, recent research points to the importance of cognitive proximity over geographical proximity for knowledge transfers to take place (Boschma, 2005; Torre and Rallet, 2005; Frenken et al., 2007). However, despite the improvements in various types of infrastructure, face-to-face contacts are still emphasized because direct contacts ease the formation of relationships, networks, and trust (Storper and Venables, 2004). Gaspar and Glaeser (1998) show that ICT is complementing rather than substituting face-to-face interactions. This view is supported by recent empirical work showing a strong distance decay in non-market externalities (Arzaghi and Henderson, 2008; Koster et al., 2014; Andersson et al., 2016). Additionally, without the acknowledgement of agglomeration economies, that is, external increasing returns to scale, it is difficult to explain the existence of cities.

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2 http://s3platform.jrc.ec.europa.eu/
(Lucas, 1988; Anas et al., 1998; Duranton and Puga, 2004). The formation and growth of cities require agglomerative forces in terms of external scale economies to counterweight dispersive forces, such as higher land rents and negative externalities from congestion (Anas et al., 1998). The spatial impossibility theorem even states that without benefits from co-location, transport costs work as a spreading force resulting in fully autarchic locations (Starrett, 1978), an outcome that is clearly not observed in the real world.

The urbanization process going on in many places around the world, including Sweden, together with a spatial wage structure with higher wages in larger cities, indicate that size and location may be becoming more relevant than ever. Figure 1 shows the population and population density in Swedish labor market regions, illustrating a far from uniform geographical distribution of people. The maps show that the population is concentrated to the three largest urban areas in Sweden; Stockholm (Sthlm), Gothenburg (Gbg), and Malmö. The maps also show the sparseness in population of many regions in the northern part of the country.

At the same time, there has been an economic restructuring of many countries, especially in the Western part of the world, from a strong industrial focus to a growing service sector, towards the contemporary knowledge-based economy. Since factors such as education, research, and innovation are at the core of such an economy (cf. Raspe and Van Oort, 2006), agglomeration economies, particularly in the form of knowledge and information spillovers, can be argued to play an increasingly important role.

The underlying assumption in this thesis is thus that geographical proximity does matter, which implies that to analyze knowledge externalities, it is beneficial to use rather small geographical units. In Papers 1 and 2, the potential sources of knowledge spillovers are measured at the municipality level, while Papers 3 and 4 use the neighborhood level, where the neighborhoods are represented by squares of 1 km² or parishes. These variations reflect that spillover effects operate at different spatial scales. Agglomeration economies in terms of matching and sharing may for example extend across urban areas, while externalities related to learning and knowledge spillovers, commonly facilitated by social interactions, are more bounded in space (cf. Duranton and Puga, 2004). In Paper 2, the analysis is conducted at a regional level, despite a strong focus on knowledge spillovers between individuals. This choice of spatial scale facilitates comparisons with the regional study of Frenken et al. (2007), which is the point of departure for this paper. The change of geographical level between the papers also reflects improvements in data availability over the years.

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3 Which can be argued to reflect higher productivity due to faster learning, recall Duranton and Puga (2004).
Figure 1. Total population (left map) and population per km² (right map) in Swedish labor market regions 2015. Source: Own maps based on data from Statistics Sweden.

The thesis consists of five chapters, including this introduction. The introduction is followed by four empirical papers that exploit employer-employee matched, spatially disaggregated, full population micro-data, obtained from Statistics Sweden. All papers are independent pieces. Thus, what papers to read and the order in which to read them is entirely up to the reader. Returning to the quote by Hoover and Giarratani (1985) that started this introduction, the four papers provide some answers mainly to the so what part of the question posed.

The first paper The Impact of Spatial Externalities: Skills, Education and Plant Productivity focuses on how the productivity of manufacturing plants is affected by a rather broad range of sources of spatial externalities, including diversity. The second paper Which Types of Relatedness Matter in Regional Growth: Industry, Occupation and Education (co-authored with Professor Martin Andersson) analyzes (related) diversity as a source of knowledge spillovers and connects this to productivity and employment growth at regional level. This paper provides an important conceptual discussion on individuals as the central agents behind knowledge spillovers, which is supported by the empirical findings. The third paper Neighborhood Related
Diversity, Human Capital, and Firm Innovation builds on the second paper, but focuses on firm innovation rather than regional growth. Finally, the fourth paper Segregation and Individual Employment: A Longitudinal Study of Neighborhood Effects (co-authored with Dr. Lars Pettersson) undertakes the analysis at the individual level and links employment to externalities produced by residential segregation, which can be seen as a measure of inverse diversity\(^4\). Considering the recent developments in Europe in general, and in Sweden in particular – with large refugee flows (Swedish Migration Agency, 2016), increases in segregation, and violence in distressed neighborhoods – this paper has strong bearing on integration policies as well as urban and regional planning.

The indicators of economic performance employed in this thesis are all connected to economic growth theory, which has its modern roots in neoclassical growth theories, presented in section 2.1, as well as endogenous growth models that allow for increasing returns to input factors; see section 2.2. Despite economic growth being the starting point of this thesis, it can be mainly positioned in the field of regional economics. Regional economics is mainly based on two theoretical backgrounds: early location theories, section 3.1, and theories concerning external economies, section 3.2. Additionally, the papers in this thesis follow and expand on more recent advances in regional economics or related research fields\(^5\), as presented in section 4. Section 5 focuses on the phenomenon of non-market - or social – interactions, which is an important aspect that helps to explain why and how locational factors matter for economic performance. The studies presented in Papers 1-4 of this thesis are subject to many empirical choices and considerations, of which some are described and motivated in section 6. Section 7, the final section of this introductory chapter, summarizes the aims and contributions of the four remaining chapters.

## 2 Economic performance

The foundation of modern economic growth theory dates back to classical economists such as Smith (1776), Malthus (1798), and Ricardo (1817), as well as Ramsey (1928), Young (1928), Schumpeter (1934), and Knight (1944). They introduced features such as competition and equilibrium dynamics, diminishing marginal returns and the connection to physical and human

\(^4\) Segregated neighborhoods are characterized by low levels of diversity in population.

\(^5\) Regional economics is closely related to urban economics, as well as Krugman’s (1991) New Economic Geography, due to the emphasis on the location of economic activity. There are also similarities between regional economics and economic geography in the questions posed, although research in the two fields is commonly conducted using different methodological approaches (Duranton and Rodriguez-Pose, 2005).
capital, the relationship between per capita income and population growth, monopoly as a means of technological progress, and specialization as a result of technological progress (Barro and Sala-i-Martin, 2004). This section focuses on modern growth theory, starting with the neoclassical growth model developed in the 1950s, moving on to endogenous growth models. Economic growth theory is presented here since it places productivity and employment (growth) as well as innovation, which constitute the dependent variables in this thesis, into a theoretical framework. In addition, economic growth theory relates to both human capital and knowledge spillovers, which are in the focus of this thesis.

2.1 Neoclassical growth models

A natural point of departure for modern growth theory is the neoclassical model developed by Solow (1956) and Swan (1956). Important assumptions of the model include competitive behavior, constant returns to scale, diminishing returns to individual inputs, and an exogenous savings rate. The foundation of the model is a basic production function that explains output, $Y$, by inputs in the form of physical capital, $K$, and labor, $L$; see equation (1).

$$ Y(t) = F(K(t), A(t)L(t)) $$

In equation (1), labor, $L$, is multiplied by $A$, which denotes effectiveness of labor. An increase in $A$ can be interpreted as technological progress. Time, $t$, has only an indirect effect on $Y$, which implies that output changes over time only if the inputs to production change. In the neoclassical growth model, per capita economic growth can be achieved either by continuously increasing physical capital or by technical change. In the model, technological progress, $\dot{A}$, and population growth, $\dot{L}$, are exogenously determined, while increases in capital, $\dot{K}$, are endogenous\(^6\), as shown by equations (2)-(4):

$$ \dot{A}(t) = gA(t) $$

$$ \dot{L}(t) = nL(t) $$

$$ \dot{K}(t) = sY(t) - \delta K(t) $$

where $g$ and $n$ are exogenous parameters showing the growth rate of knowledge and labor, respectively. In equation (4), $s$ is the savings rate, and $\delta$ is the depreciation rate of capital; both are exogenously determined. All growth in productivity (per capita economic growth) that is not explained by increases

\(^6\) A dot over the variable denotes a time derivative, for example, $\dot{A}(t) = dA(t)/dt$. 

in capital is attributed to technological progress, in other words, increases in knowledge. Innovation is thus (assumed) to be at center stage in the model despite not being explicitly modeled but treated as a residual. Due to the assumption of diminishing returns to capital, productivity cannot grow indefinitely in the absence of technological progress.

Solow (1957) provides an early empirical test of the neoclassical growth model using U.S. data from 1909 to 1949. The results show that only 12.5 percent of the increase in average labor productivity between these years can be accredited to increases in the volume of capital. The remaining 87.5 percent is assumed to be due to technical change, which shows the importance of the generation, diffusion, and accumulation of knowledge.

The empirical results in Solow (1957) identify an important subject for further research, that is, decomposing and explaining $A$ in equation (1). Mankiw et al. (1992) make an attempt at this by augmenting the Solow-Swan model with human capital. This points to the importance of accounting for skilled labor. It also acknowledges the heterogeneity in labor in terms of, for example, education and productivity. Mankiw et al. (1992) find that when including human capital, measured as a percentage of population with secondary education, the model explains 80 percent of the differences in growth between the 98 countries included in the study over the time period 1968-1985. The income (production) elasticity is one-third for each of the three input factors; physical capital, human capital, and labor, again showing the importance of knowledge for economic growth. The notion that investments in human capital promote economic development has long been established; see, for example, Becker (1964) and Mincer (1958; 1984), and the positive relationship between education and growth has been confirmed empirically in several studies (Barro, 1991;2001; Glaeser et al., 1995).

Since Mankiw et al. (1992) assume diminishing marginal returns also for human capital, their model does not qualify as an endogenous growth model. A central feature of the neoclassical model that follows from the assumption of diminishing marginal returns is that it predicts economic convergence between economies, for example, countries or regions; countries with less capital per worker, commonly poorer ones, are expected to grow faster than richer countries due to higher rates of return on investments. This idea has been challenged by endogenous growth theorists such as Romer (1986). Endogenous growth models can be viewed as extensions of the Solow-Swan model, the main difference being that technical change is endogenously determined by allowing for increasing returns to production factors.

### 2.2 Endogenous growth models

The study of economic growth was revitalized in the 1980s, primarily through the work on endogenous growth models of Romer (1986) and Lucas (1988).
Romer (1986) developed a model with endogenous technological change where the key novelty is that knowledge is treated as an input factor with increasing returns. The increasing returns to knowledge are explained by knowledge being a non-rival, partially excludable good. It is thus not possible for firms to totally internalize new knowledge, which implies that there will be natural spillover, or external, effects on the production in other firms. In Romer’s (1986) model, knowledge accumulation by forward-looking, profit-maximizing economic agents is the main driver of long-run economic growth. Knowledge is created as a by-product of research and production. That is, new knowledge is created by learning-by-doing, in this context a notion that goes back to Arrow (1962). One difference from the neoclassical growth model then is that knowledge, and not only physical capital, is endogenously accumulated. Another difference with the Solow-Swan model is that due to the increasing returns to knowledge, Romer’s (1986) model does not predict economic convergence between regions and countries. Through endogenous accumulation and increasing returns to knowledge, already rich and advanced economies can grow faster than initially poorer ones.

In addition, Lucas (1988) applies the neoclassical model as a point of departure and includes human capital, which consists of individuals’ skill levels. Lucas (1988) argues that some effort is required to accumulate human capital and emphasizes that a difference between physical and human capital is that accumulation of the latter is a social process involving interactions with other people. Social interactions give rise to knowledge generation and diffusion; that is, knowledge spillovers that are not conceivable for physical capital, which supports the ideas put forward in section 5. Lucas (1988) models human capital accumulation as both formal schooling and learning-by-doing. Neither Lucas (1988) nor Romer (1986) explicitly model technological change but use the endogenous accumulation of knowledge and human capital as the main driver of economic growth. This indicates the existence of external effects in the same sense as discussed in the introduction and described more thoroughly in section 3.2. Indeed, the ideas of Romer (1986) and Arrow (1962) are part of the so-called MAR (Marshall-Arrow-Romer) externalities, which represent benefits from industrial specialization (Glaeser et al., 1992). Technological change is more explicitly determined in later works by Romer (1987;1990) as well as Aghion and Howitt (1992) and Grossman and Helpman (1993) that incorporate both imperfect competition and investments in research and development (R&D). For the purpose of this thesis, the earlier endogenous growth models that deal with knowledge externalities as well as social interactions provide a more relevant framework for the empirical studies in Papers 1-4. Indeed, even though Lucas’ (1988) models are based on aggregate (national) development, he follows Jacobs (1969) in a discussion on human capital externalities as the main force for the existence and growth of cities.
3  Theoretical foundations of regional economics

According to Hoover and Giarratani (1985, p.4), regional economics “…represents a framework within which the spatial character of economic systems may be understood”. Siebert (1969, p.1) defines regional economics as “…the study of man’s economic behavior in space. It analyzes economic processes in a spatial setting…” . The common denominator of these definitions is the inclusion of space and spatial factors in economic studies, which captures the essence of regional economics.

The following subsections focus on early location theories and theories of external economies of scale. Considering the focus on knowledge externalities, the latter is the more important cornerstone of this thesis.

3.1  Early location theories

Regional economics originates from models developed by early location theorists, such as von Thünen (1826), Weber (1929), Christaller (1933), and Lösch (1940). In von Thünen’s (1826) model of the isolated state, a small city is located in the middle of a flat featureless plain surrounded by wilderness. The city is encircled by rural land devoted to various types of agricultural production, which are sold at city markets. Transport costs give rise to competition for land and thus higher land rents closer to the city. All producers act to maximize profits, which results in an equilibrium where producers that face higher transport costs and/or requires less land are located closer to the city. This results in concentric circles of various land uses surrounding the city, commonly denoted as “von Thünen rings”.

Following the ideas of von Thünen (1826), Alonso (1964) develops the monocentric city model by replacing the single city by a central business district (CBD) and the agricultural producers by commuters. Commuters derive utility from residential space (land), which is homogenous in all aspects except that being closer to the CBD implies lower commuting costs, which in turn implies higher land rents. This set-up is analyzed using bid-rent curves, where each curve shows the willingness-to-pay for land of the respective actor in the economy, for example, households and firms. Using bid-rent theory the allocation of land for various uses can be derived; see Figure 2. Between the central point of the plain (the CBD) and point A, ‘Commerce’ has the highest willingness-to-pay for land, as shown by the bid-rent curves, and the dark inner circle is thus devoted to commercial use. At an intermediate distance from the CBD (between points A and B), ‘Industry’ is willing to pay more for land than both ‘Commerce’ and households, resulting in industries occupying
the middle circle. Finally, at a longer distance from the CBD (between points B and C), households have the highest willingness-to-pay for land. The outer light blue circle is thus residential area. At an even longer distance from the CBD, no actor is willing to pay for land, which results in the plain being surrounded by wilderness. The Alonso model is commonly integrated with the work of Mills (1967) and Muth (1969), who extend the model by including a housing production sector, to provide a general framework for urban economics.

Transport costs are an important element in early location theory. For example, in the monocentric city model it is transport costs that give rise to competition for land. The importance of transport costs was recognized also by Weber (1929) in his theory of industrial location. According to Weber (1929) industries choose location to minimize costs, which includes transport costs, in terms of moving both inputs and final products, as well as labor costs. Weber’s model shares similarities with the less recognized work by Launhardt (1885).

One of the major critiques of the monocentric city model – and one reason why it is a model for urban rather than regional economics – is the focus on a
single city. In contrast, central place theory, associated with Christaller (1933) and Lösch (1940), analyzes a system of cities of various sizes. Larger cities are more distant from each other and perform more functions than smaller villages. Typically, smaller places only provide lower-order goods with limited or no returns-to-scale properties. These types of goods can also be found in larger places that also provide higher-order goods facing increasing returns to scale. There is thus a greater variety in larger cities, and as consumers from smaller villages need to travel to the city in order to buy the higher-order goods, larger cities have a greater catchment area.

An important feature of the central place theory is that it incorporates increasing returns, however, only at the firm level, that is, internal economies of scale.

3.2 External economies

While providing important foundations to explain the location of economic activity, neither of the early location theorists model external effects, at least not beyond those that result from closeness to the CBD. However, Fujita (1989) provides a modification of the monocentric city model that explicitly accounts for spatial agglomeration and product variety, which relates to Papers 1-3 of this thesis, and neighborhood effects associated with, for example, prejudices against certain groups of the population, which is more thoroughly explained in Paper 4.

Regional economics is also founded in theories of external economies of scale. The existence of such scale effects implies benefits that arise from an increase in size beyond the firm. For example, a reduction in production costs due to an increase in output at the industry level. This type of agglomeration externality is commonly associated with Marshall (1890), who claimed that firms benefit from being situated in specialized economic environments. He argued that concentration of one industry in a city facilitates information spreading and promotes knowledge spillovers within that industry. This increases productivity and growth in both the industry itself and the city as a whole. In addition, the functioning of labor markets benefits from industry concentration; when there are more firms that employ similar workers the labor matching process is smoother. Marshall (1890) also asserted that cities benefit from specialization due to reductions of transport costs. If all firms in an industry locate close to the input sources, the costs of moving inputs are minimized. Benefits from spatial concentration and specialization are

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7 Goods that are bought frequently, usually inexpensive.
8 As noted in the introduction, Marshall (1890) was not only an advocate of specialization but argued also for the benefits of diversity. However, in empirical research on spatial externalities Marshall (1890) is mainly associated with localization economies, commonly measured in terms of industry specialization.
generally denoted localization economies. In contemporary research such benefits are commonly studied under the term MAR externalities, after Marshall (1890), Arrow (1962), and Romer (1986;1990); they were labeled this way by Glaeser et al. (1992).

Another perspective is that diversity is the main driver of firm innovation, regional development, and national growth, commonly associated with Jacobs (1969;1984). In particular, Jacobs (1969) emphasizes cities as the engine of the economy because of the wide variety of people and industries that cities are commonly comprised of. This diversity facilitates new ideas and productive knowledge spillovers, and thus innovation and technological progress and thereby economic growth. Accordingly, benefits from diversity are commonly labeled Jacobs externalities. Jacobs’ (1969) view of diversity is part of what is denoted urbanization economies. In addition to benefits from diversity, urbanization economies represent advantages from size and density, that is, benefits from concentration of economic activity in general, irrespective of sectoral composition.

The distinction between localization economies, that is, benefits from co-location of firms producing similar goods, and urbanization economies, in other words, benefits from size and diversity, can be traced back to Ohlin (1933) and Hoover (1948) and is more recently discussed by Fujita and Thisse (2002). Urbanization economies and localization economies together constitute what is generally labeled agglomeration economies (cf. Johansson and Forslund, 2008). As noted in the introduction, without the acknowledgement of such external effects, it is difficult to explain the clustering of economic activity, that is, the existence of cities (Duranton and Puga, 2004; Krugman, 1991). In the presence of transport costs and a homogenous space and in the absence of indivisibilities and no benefits from co-location, that is, no external increasing returns, equilibrium implies full autarchy in each location, a result denoted as the spatial impossibility theorem by Starrett (1978). In such a situation, transport costs and negative external effects from clustering, such as crowding externalities, racial externalities, and traffic congestion, work against agglomeration (cf. Fujita, 1989). Another spreading force is the higher land prices in more agglomerated areas. The latter is an example of an external effect that operates through changes in market prices, denoted pecuniary externality by Scitovsky (1954). In contrast, pure (or technological) external effects are concerned with information and knowledge spillovers that materialize through non-market interactions (Scitovsky, 1954). Pure externalities are more challenging to measure since they take place outside the market without any (economic) reimbursement for the sources of the spilled-over knowledge (Johansson, 2005). Johansson (2005) provides an excellent overview of various forms and mechanisms of externalities, distinguishing between i) efficiency and innovation externalities, ii) proximity versus network externalities, and iii) pecuniary and non-
pecuniary externalities. Non-pecuniary externalities correspond to Scitovsky's (1954) pure externalities, in other words, knowledge spillovers.

Scitovsky’s (1954) pure externalities can also be seen as corresponding to the learning mechanism of agglomeration economies identified by Duranton and Puga (2004). This mechanism captures the faster generation, diffusion, and accumulation of knowledge in more urban areas. In addition to learning, Duranton and Puga (2004) distinguish between greater opportunities for sharing of indivisible facilities, input suppliers, and risk, and better matching on the labor market, as micro-foundations of agglomeration economies. This provides a framework for studying the mechanisms behind the formation of cities and the location choices of firms and individuals, as well as the role of agglomeration economies for economic performance. Duranton and Puga (2004) conclude that heterogeneity of firms and individuals is at center stage in all three mechanisms of agglomeration economies and can thus be argued to side with Jacobs (1969) in the specialization-diversity debate that has been going on since the beginning of the 1990’s (cf. Beaudry and Schiffauerova, 2009; Van Oort, 2015). Diversity is also highlighted in the theories of monopolistic competition introduced by Chamberlin (1933), developed by Dixit and Stiglitz (1977), and put in a spatial context by Fujita (1988), which shows increasing returns to product variety.9

4 Related variety and proximity

The end of the previous section hints at an ongoing debate in urban economics, economic geography, and regional science regarding whether specialization or diversity promotes economic performance (Beaudry and Schiffauerova, 2009). To this date, empirical research on agglomeration economies, following the seminal contributions of Glaeser et al. (1992) and Henderson et al. (1995), are inconclusive. Beaudry and Schiffauerova (2009) argue that this is mainly due to methodological differences. Van Oort (2015, p. 259), following studies by, for example, Paci and Usai (1999) and Duranton and Puga (2000), maintains that “…both specialization and diversity are important for regional economic performance - on different levels, for different time periods, over different periods in the industry life cycle and in different institutional settings.” This implies that the question of specialization versus diversity is more complex and not as dichotomous as commonly presented. There may be various degrees of specialization and diversity and the influence on economic performance depends on the specific context.

9 Although these benefits are a result of price interactions, that is, pecuniary external effects, rather than pure externalities in terms of knowledge spillovers.
In the mid-2010s the field of evolutionary economic geography (EEG), mainly as a result of Frenken et al. (2007), revitalized the concept of *related variety*\(^{10}\), which can be argued to fall somewhere in between specialization and diversity; see Figure 3.

**Figure 3.** Relationship between agglomeration economies, urbanization economies, localization economies, and related variety and the role of geographical and cognitive proximity. *Source: Own illustration.*

Figure 3 shows that the concept of related variety shares elements with both urbanization and localization economies, particularly in the form of Jacobs and MAR externalities. Related variety can thus be viewed as a specialized diversity, or a diversified specialization. The arrow between agglomeration economies and related variety is in dashed form since related variety does not necessarily have a geographical component, which per definition is the case for agglomeration economies.

The argument for the importance of related variety is that knowledge spillovers are most effective if there is some sort of complementarity, relatedness, or common knowledge base between actors. This follows from Nooteboom (2000, p.153), who maintains that “...information is useless if it is not new, but it is also useless if it is so new that it cannot be understood”. There may thus be an optimal level of (cognitive) proximity that facilitates

\(^{10}\) See Jacquemin and Berry (1979), Attaran (1986), and Hoskisson and Johnson (1992) for earlier applications of related variety.
communication, knowledge transfer, and networking but simultaneously maintains creativity and the stimulation of new ideas (cf. Boschma, 2005; Boschma and Frenken, 2010; 2011b). Many empirical studies have followed in the footsteps of Frenken et al. (2007) in the application of related variety for various countries and time periods (cf. Bishop and Gripaios, 2010; Boschma et al., 2012; Hartog et al., 2012; Mameli et al., 2012). In addition, Papers 1-3 in this thesis analyze the concept of related variety.

Earlier theories and research on agglomeration economies center around geographical clustering or co-location and are thus concerned with spatial or geographical proximity between economic actors. This is indicated by the solid arrows between geographical proximity and agglomeration, urbanization, and localization economies in Figure 3. A contribution of EEG and the literature on related variety is that it highlights the importance of proximity beyond the geographical dimension, particularly cognitive proximity (Boschma and Frenken, 2011a). Boschma (2005, p.62) argues that “…geographical proximity per se is neither a necessary nor a sufficient condition for learning to take place”. Boschma (2005) also discusses organizational, social, and institutional proximity, and maintains that these can work as substitutes for geographical proximity to enhance interactive learning through cognitive proximity. This is similar to the ideas of Johansson and Quigley (2004), who argue that (a-)spatial networks may work as substitutes for agglomeration to facilitate knowledge externalities. Indeed, Johansson (2005) distinguishes between link and (geographical) proximity externalities. The formation of links, that is, networks, is likely to be enhanced by organizational, social, and/or institutional proximity. The notions on proximity of Boschma (2005) can be viewed as an extension of the French School of Proximity Dynamics (see, for example, Torre and Gilly (2000) and Torre and Rallet (2005)) that distinguishes mainly between geographical and organizational proximity. Cognitive proximity is embedded in the organizational dimension. Additionally, Capello and Faggian (2005) separate between physical and cultural proximity, where the latter provides a base for relational capital that promotes collective learning.

Since the focus in this thesis is on the role of individuals in knowledge spillovers, cognitive proximity is an important element, particularly in Papers 2 and 3. However, following earlier theoretical and empirical research, presented in sections 3.2 and 6.1, an underlying assumption is that the role of geographical proximity should not be downplayed. Indeed, a common empirical approach is to combine geographical and cognitive proximity by, for example, measuring related variety (to capture cognitive proximity) at the regional level (to capture geographical proximity) (cf. Frenken et al., 2007). This explains the dashed arrow from geographical proximity to related variety in Figure 3.

The arrow between cognitive proximity and localization economies is also in dashed form in the figure since the motivations for related variety imply
that specialized industrial districts have a more than optimal level of cognitive proximity. This is reflected in the (policy) concept of smart specialization (cf. McCann and Ortega-Argilés, 2015), which follows from the same line of thinking as related variety. Indeed, the central ideas of smart specialization include embeddedness, relatedness, and connectedness (McCann and Ortega-Argilés, 2015). In simple terms, smart specialization means that regions should focus on locally strong areas (industries) and develop into areas related to these. The literature on both related variety and smart specialization points to negative effects from too much cognitive proximity. These so-called lock-in effects result from a lack of openness and flexibility, which hamper the generation and spreading of new ideas and knowledge. For the same reason, too much organizational and/or institutional proximity, as well as social proximity, may be harmful for learning and innovation (Boschma, 2005). This implies that even though social interactions are fundamental for knowledge spillovers and learning, as already noted in section 3.2 and discussed further in the following section, some social distance is required for these interactions to be effective from a learning point of view. This is especially relevant for the last paper of this thesis, which discusses lock-in effects of segregated neighborhoods.

5 Social interactions

An important aspect that helps to explain why and how locational factors matter is the phenomenon of non-market - or social - interactions. As mentioned above, Scitovsky’s (1954) pure spillover effects materialize through non-market interactions. Such interactions can result in both intentional and unintentional knowledge spillovers that affect the economic performance of individuals and firms. As a result, the economic performance of the location as such may be affected in terms of, for example, increases in regional productivity and innovation levels. According to the different theories on agglomeration economies (see section 3.2), the way these externalities materialize in a location is a function of the composition of the economy in that place, that is, the spatial characteristics. A (positive) relationship between a potential source of knowledge spillovers, such as regional diversity, and economic performance can be interpreted as an external effect (cf. Jacobs, 1969). This effect may be a result of direct knowledge transfer, “local buzz” (Bathelt et al., 2004; Storper and Venables, 2004), or of individuals adjusting their behavior due to peer effects (cf. Debreu, 1952; Schelling, 1971,1973; Becker, 1974). Regardless of which of these mechanisms is the most important, interaction between individuals is essential. Following the ideas of Marshall (1890), Glaeser (1999) formalizes a theoretical model that shows that learning is faster in dense environments, which is due to higher degrees
of human interaction. Social interaction is therefore a common explanation for higher productivity in cities, commonly measured as the urban wage premium (UWP) (Glaeser and Maré, 2001). In addition to learning, the UWP can be explained by more efficient matching in cities (Glaeser and Maré, 2001), which can also be argued to be a function of social interactions due to, for example, the spread of information on job openings and job seekers.\footnote{However, Andersson et al. (2014) show that spatial sorting is more important than agglomeration economies, for example, learning and matching, in determining the UWP.}

Glaeser et al. (2000) argue that non-market interactions are fundamental to understand the spatial distribution of economic activity, and vice versa. This follows from the embeddedness literature in sociology that argues that economic relations between individuals and firms are always embedded in social relations (Polanyi, 1944; Granovetter, 1985). The importance of social interactions can be argued to be due to the fact that the exchange of knowledge is facilitated by trust and social relationships, in particular when the knowledge is of a tacit character (Maskell and Malmberg, 1999a). Although social interactions are discussed most explicitly in Paper 4, they are important elements in every paper of the thesis. In Papers 1-3, social interactions are implicitly positive as the mechanism through which the various spatial compositions influence economic performance. However, as discussed above too much social proximity in these interactions may imply negative effects on learning, and thus on economic outcomes of regions, firms, and individuals. This can be connected to Putnam’s (2000) theory on bonding and bridging social capital, as well as the sociological theory of strong and weak ties (Granovetter, 1973).

Communities or networks with high levels of bonding social capital are comprised of homogenous groups with strong ties and high levels of social proximity, typically close family and friends or other groups that share a common denominator, such as religion (cf. Ahmed and Hammarstedt, 2011). In contrast, networks between socially heterogeneous groups are connected by weak ties and high degrees of bridging social capital. Weak ties are more sporadic acquaintances that share less social proximity. Bridging social capital and weak ties are important for economic development since they allow for the sharing of information, knowledge, and ideas between sectors, firms, and groups of individuals. Granovetter (1973) even argues that too strong ties may hinder participation in weak ties networks, which is unfavorable since these networks are of particular importance for learning and knowledge transfer, for example, the spreading of information on job opportunities. Nevertheless, Andersson and Hammarstedt (2015) find a positive relationship between ethnic enclaves and immigrant self-employment, which implies that socially homogenous groups may be beneficial for certain labor market outcomes. On the other hand, this can be interpreted as supporting the thoughts of Granovetter (1973), since self-employment may be driven by a lack of other employment opportunities (cf. Hammarstedt, 2004).
6 Empirical issues and data

6.1 Geographical scale

The seminal papers of Glaeser et al. (1992) and Henderson et al. (1995) can be seen as the starting points for the empirical research on agglomeration economies, or externalities. In early contributions, and to some extent also in contemporary research, the unit of analysis is at an aggregate level, for example, cities, regions, or city industries. However, this approach does not account for the heterogeneity at the micro level, that is, differences between firms and individuals, in particular in terms of human capital, which is commonly shown to be the most important determinant in explaining firm performance (cf. Black and Lynch, 1996; Sternberg and Arndt, 2001; Raspe and Van Oort, 2006; Antonelli et al., 2013; as well as Paper 1 (Wixe, 2015) and Paper 2 (Wixe, 2016) in this thesis). To avoid the issue of ecological fallacy, that is, assuming that relationships found at the macro level are valid also at the micro level, it is beneficial to conduct the analysis at the firm or even individual level, depending on the research question (cf. Van Oort, 2015). This means that even though the variables of interest are measured at some aggregate level, performance should be measured at the micro level. This is becoming an increasingly common methodological approach, which is due to increased awareness combined with improvements in the availability of micro-data.

The empirical studies in this thesis are conducted using an extensive longitudinal micro-level data set, maintained by Statistics Sweden. The data set contains detailed information about all firms, establishments, and
individuals in Sweden between 1990 and 2011\textsuperscript{12}, which allows for full population studies. The three units of observation in the data set are joined by numerical identifiers connecting each working individual to both an establishment and a firm, as well as establishments to their respective firm. For firms, variables such as number of employees, industry code, material assets, value added, exports and imports, and year of establishment are available. Establishment information includes industry code and number of employees. The richest data are available for individuals, where education length and specialization, as well as occupation, employment status, gender, age, foreign background, and civil status are reported among other variables. Access to this data provides unique possibilities for conducting micro-level studies, such as those presented in Paper 1, 3, and 4 in this thesis.

Another empirical issue concerns the relevant spatial scale to measure the potential sources of external effects. Again, a common approach in particularly earlier empirical research is to employ labor market regions or cities. This is recognized by Duranton and Puga (2004), who identify a need for more studies of agglomeration economies at smaller spatial scales. As already noted in the introduction, the relevant spatial scale may depend on the type of externality that is supposed to be captured. In particular, recent empirical research finds a strong distance decay of non-market effects of agglomeration economies, such as knowledge spillovers. Arzaghi and Henderson (2008) show this by identifying firms within a 250 meter radius, Andersson et al. (2016) employ squares of \(1 \times 1\) km and \(250 \times 250\) meters, and Koster et al. (2014) even look at within-building effects. The results by Van Soest et al. (2006), Van Oort (2007), Baldwin et al. (2008) and Rosenthal and Strange (2008) also indicate that agglomeration economies are spatially bounded, even though their geographical resolutions are not quite as fine-grained as in the above-mentioned studies.

That knowledge spillovers are neighborhood effects rather than regional effects is not only an empirical phenomenon. Already Marshall (1890) acknowledged the importance of direct contact between economic agents for knowledge transfers to take place. However, due to the exponential increase in the quality of information and communication technology as well as vast reductions in transport costs, the possibilities for longer distance travel and communication are much greater in the 21\textsuperscript{st} century than in Marshall’s 19\textsuperscript{th} century. Despite this, face-to-face contact is still highlighted as an important source of knowledge spillovers because direct contact eases the formation of relationships, networks, and trust (Storper and Venables, 2004). In addition, earlier empirical contributions by, for example, Jaffe et al. (1993), Audretsch and Feldman (1996), and Baptista (2000) confirm the role of geographical proximity for knowledge diffusion.

\textsuperscript{12} This is the year span that was accessible at the time of writing of the papers included in this thesis.
An important aspect of this thesis is thus to determine the geographic location of the economic agents (firms, individuals) of interest. The data allow for this by providing geographic information for individuals and establishments. The smallest spatial resolutions reported are coordinates that correspond to squares with an area of 1 square kilometer; in urban areas the squares are as small as 0.0625 square kilometers. Additional geographic areas employed in this thesis are parishes (n = 2,513), which represent neighborhoods, and municipalities (n = 290). In Sweden, municipalities constitute the smallest geographical units used for administrative and self-governing purposes; for example, the majority of income taxes are collected at the municipality level. The 290 municipalities can be aggregated into 93 labor market areas\textsuperscript{13} (see Figure 1) based on cross-border commuting flows as well as various region types. In this thesis, the classification by the Swedish Board of Agriculture is applied, which distinguishes between metropolitan (47 municipalities), city (46 municipalities), and rural\textsuperscript{14} (197 municipalities) regions, as shown by Figure 4. The municipalities are categorized into region types based on commuting patterns between municipalities, as well as population size and density within municipalities (Swedish Board of Agriculture, 2013). While there have been changes in the geographic division of municipalities in Sweden since 1990, the geographic division into parishes is fixed in the data and corresponds to the division that was prevalent on the 1\textsuperscript{st} of January 2000, at which date the church was separated from the state.

Regarding firms and establishments, location is thus given at the establishment level, while most information, regarding, for example, value added and exports, is given at the firm level. This is dealt with by using the establishments’ shares of employment in their respective firms as weights to distribute the firm values to the establishment level, as done by Martin et al. (2011). This is not an issue for the employee characteristics of establishments since there is a direct link between employees and establishments.

\textsuperscript{13} These correspond to the 72 Functional Analysis regions with sub-regions identified by the Swedish Agency for Economic and Regional Growth (2016).

\textsuperscript{14} Rural and sparse rural have been combined into one category due to relatively few municipalities (33) classified as sparse rural.
Figure 4. The 290 Swedish municipalities classified into three region types; metropolitan, city, and rural. Source: Own map.

6.2 Human capital

Although the data set as such stretches over 22 years not all variables are available for the whole time period. For example, information on occupation is only available from 2001, and changes in standard industrial classifications pose problems for conducting long panel analysis at the establishment or firm level. Occupation is a particularly important variable in this thesis since it represents human capital, or skills, beyond the educational dimension. Indeed, previous research has highlighted individual skills and abilities beyond education. Florida (2002) introduced the creative class, Autor et al. (2003) focus on routine and non-routine tasks, and Bacolod et al. (2009) distinguish between cognitive skills, people skills, and motor skills. The common denominator is that these measures of skills are based on an occupational rather than educational classification. Florida et al. (2008) and Mellander and Florida (2011) show that occupation based measures of skills
are stronger determinants of regional labor productivity than education. Additionally, Lucas (1993) argues that human capital accumulation in terms of on the job training is relatively more important than schooling to explain economic growth. The first and the third paper of this thesis employ the classification of Swedish occupational codes by Johansson and Klaesson (2011), which is based on the skill categories of Bacolod et al. (2009). In addition, higher education is highlighted in this thesis, as it continues to be an important measure of the degree of human capital possessed by individuals, establishments, and firms, as well as regions (cf. Glaeser et al., 1995; Berry and Glaeser, 2005; Faggian and McCann, 2009; Glaeser and Resseger, 2010; Florida et al., 2013; Backman, 2014).

Education and occupation are also emphasized in this thesis as important factors in order to capture the cognitive proximity between individuals and firms. Following Frenken et al. (2007), a common method to measure cognitive proximity is to apply standard industrial classifications (SICs) or product codes based on the assumption that firms that operate in similar industries or produce similar outputs are cognitively related. This approach of approximating cognitive proximity has been criticized by Desrochers (2001), Ejermo (2005), Brachert et al. (2011), Desrochers and Leppälä (2011), and Boschma et al. (2012), among others. For example, Desrochers (2001) argues that different industries, as judged by SICs, share functional processes and material, and firms producing different outputs often use related production technologies. In addition, the multi-product nature of many firms is not visible in SICs.

Additionally, Paper 2 in this thesis (Wixe and Andersson, 2016) adds to the critique and argues that cognitive proximity should be framed at individual level and thus be measured in terms of the human capital, skills and experience of individuals. That individuals, and not firms, are the main agents for knowledge spillovers follows from the fact that both the learning and the matching mechanisms of agglomeration economies (Duranton and Puga, 2004) emphasize individuals. Knowledge is transferred by and through actual human beings. Furthermore, an increasing functional specialization implies that firms have different educational and occupational compositions in different locations, despite sharing the same industry code (cf. Duranton and Puga, 2005). The importance of individual skills in capturing relatedness is also acknowledged in the skill relatedness measure developed by Neffke and Henning (2013). Relatedness between industries is then inferred from inter-industry labor flows under the assumption that industries that “share” the same type of employees are related.
6.3 Innovation

The third paper of this thesis focuses on firm innovation, which raises the question of how to measure innovative activity. To manage this, the 2010 version of the Community Innovation Survey (CIS) for Sweden is added to the data set. The CIS is a harmonized survey questionnaire carried out every two years in member states of the European Union as well as in other countries participating in the European Statistical System (Eurostat, 2016). Through this survey, Statistics Sweden collects information on the innovation activities of a sample of Swedish firms with at least ten employees (Statistics Sweden, 2016). This information is applied in the third paper to identify innovative firms. Since the CIS is conducted at the firm level, the same type of problem as above arises for firms with multiple establishments. This is addressed by only accounting for the largest establishment under the assumption that if the firm as such is innovative, so is its largest establishment.

Although studies based on CIS data for various countries are growing in number – see Evangelista et al. (2002), Mairesse and Mohnen (2002), Johansson and Lööf (2008), Frenz and Ietto-Gillies (2009), Horbach et al. (2013), Aarstad et al. (2016), Karlsson and Tavassoli (2015), among others – a common approach in empirical research on innovation is to use patents. Patent data are not available in the data set used for the studies in this thesis. Tavassoli (2015) argues that patents, or patent applications, are indirect measures of innovation since a patented product may never be commercialized, while surveys like the CIS provide direct measures of innovation. Additionally, patent data have been found to be biased due to different propensities to patent in various industries (Kleinknecht and Reinders, 2012). As an example, service industries are less likely to patent than, for example, high-tech manufacturing industries, which implies that patent data are not representative of innovation in service firms. Kleinknecht and Reinders (2012) argue that this is a remnant of a time when patent systems were set up to protect (and thus promote) product innovations with high development costs, which was previously the case primarily for manufacturing goods.

In contrast, a downside of using survey data on innovation is that this data commonly cover only a sample of firms and not the whole population. The data may also be restrictive in terms of the types of firms that are sampled, regarding characteristics such as size, industry, and location. For example, the CIS is only directed at firms with at least ten employees and excludes firms in agricultural industries, for example. Additionally, if surveys are not stratified, the results may not be representative for firms in rural regions. Hence, following Mairesse and Mohnen (2002), it can be argued that survey data on innovation and patent data should be viewed as complements rather than substitutes as measurements of innovation.
7 Summary and contribution of each paper

The rest of this thesis consists of four independent papers. The purpose of the first paper *The Impact of Spatial Externalities: Skills, Education and Plant Productivity* is to analyze the role of spatial externalities in explaining the productivity levels of Swedish manufacturing plants for the years 2002-10. This paper builds on the previous literature, from which four main sources of externality effects can be identified: i) size and diversity (Jacobs, 1969), ii) specialization (Marshall, 1890), and iii) competition (Porter, 1998), which give rise to Jacobs, MAR, and Porter externalities, respectively, as well as iv) labor market matching (Marshall, 1890; Maskell and Malmberg, 1999b; Power and Lundmark, 2004). Previous empirical research is inconclusive as to the effect of these externalities on economic performance, in particular concerning specialization and diversity (Beaudry and Schiffauerova, 2009), which shows the importance of further studies on this subject. What distinguishes this study from previous empirical work on externalities is that it tests for a broader than usual range of spatial externalities. In addition, this is a longitudinal plant level study, which allows for controlling for unobserved time-invariant plant characteristics, as well as heterogeneity between plants, in particular concerning employee education and skills.

In this study, full population micro-level data are employed to connect individuals to plants and plants to municipalities, which is the geographical level for the calculation of location factors, that is, the sources of externality effects. Fixed and random effects estimations are applied in order to capture short- and long-term effects, respectively, on plant productivity.

The results show that general urbanization economies (size) and labor market matching enhance productivity in the short term as well as in the long term. The results also show that within-industry diversity in the region has a negative long-term effect on productivity. These results are consistent with previous studies, despite methodological differences, which allows for wider generalization. Considering the inconclusiveness of previous research on spatial externalities, this is the main empirical contribution of this study. Additionally, region-wide industrial diversity is found to reduce productivity, both in the short and long term, while positive effects from specialization and competition are found for the long term only. Despite these significant effects on productivity from location factors, plant productivity is largely determined by plant characteristics, including the education and skills of the employees. This gives weight to the issue of ecological fallacy since plant-level variation is not retained in aggregated data, which were commonly used in earlier empirical research following Glaeser et al. (1992) and Henderson et al. (1995).
Hence, the first paper finds support for both MAR and Porter externalities, that is, positive effects from specialization and competition. Regarding Jacobs externalities, it has been argued that for knowledge spillovers to occur from a diverse economic environment, some relatedness, or cognitive proximity, is required (cf. Nooteboom, 2000; Frenken et al., 2007). The results from the first paper can thus be interpreted as if belonging to the same industry does not imply enough cognitive proximity to spur productivity-enhancing Jacobs externalities. An interesting area for further research is thus the untangling of what bodes for cognitive proximity, if not industry belonging.

This issue is addressed in the second paper Which Types of Relatedness Matter in Regional Growth: Industry, Occupation and Education (co-authored with Professor Martin Andersson). This paper builds on Frenken et al. (2007), who distinguish between related and unrelated variety, and shows that it is not variety in general but variety in related industries that promotes regional employment growth. Many researchers have followed in the footsteps of Frenken et al. (2007), which implies measuring relatedness based on standard industrial classifications, or equivalent. Although the second paper of this thesis also follows Frenken et al. (2007), it differs from the common approach in several regards. First, it provides a conceptual discussion on relatedness and argues that cognitive proximity should be framed at the level of individuals rather than firms and industries. This follows from the fact that both the matching and the learning mechanisms of agglomeration economies (cf. Duranton and Puga, 2004) and thus knowledge spillovers occur mostly at the level of individuals. Due to division of labor and functional specialization (cf. Duranton and Puga, 2005), which imply that firms have various educational and occupational compositions in different regions, relatedness based on educational background and current occupation of employees may reflect cognitive proximity to a larger extent than industry belonging. This discussion provides an important conceptual contribution of the paper.

Second, following the conceptual discussion, data on Swedish regions are used to estimate the relationships between three dimensions of relatedness and regional growth over a five-year period (2002–07). In addition to testing the relationship between regional growth and relatedness based on industrial belonging, as in Frenken et al. (2007), in this paper, educational and occupational dimensions of cognitive proximity are added. This is possible due to access to full population micro-data, which are used to calculate regional levels of related and unrelated variety based on information on individuals. The regions correspond to the 290 Swedish municipalities. The main empirical analysis employs ordinary least squares estimation on growth in employment and productivity explained by initial conditions. Additionally, panel data estimations are added as robustness tests.

The results confirm the findings by Frenken et al (2007) that related industry variety is positively related with employment growth but negatively related to productivity growth. However, the main empirical contribution is to
show that educational- and occupational-related variety matter for regional productivity growth. Relatedness in terms of sharing a common educational background appears to be particularly correlated with productivity growth in the manufacturing sector. These findings support the conceptual discussion put forth in the paper and show the importance of expanding the concept of relatedness beyond the industrial dimension. This is important from both a research and a policy perspective as relatedness is embedded in the European Union’s current regional innovation policy concept of smart specialization (cf. McCann and Ortega-Argilés, 2015).

The purpose of the third paper Neighborhood Related Diversity, Human Capital, and Firm Innovation is to empirically test the importance of neighborhood related diversity, in terms of both industry and education, and internal human capital for firms’ propensity to innovate. This paper builds on the second paper above, as it focuses on relatedness in various dimensions, but connects it to innovation rather than growth. To the best of the author’s knowledge, there are only a few studies on the relationship between related diversity and innovativeness (cf. Castaldi et al., 2015) and no previous study connecting neighborhood related diversity to firm innovation. The empirical approach is thus one contribution of this paper. At the regional level, some studies find a positive relationship between relatedness and firm innovation (cf. Lo Turco and Maggioni, 2015; Aarstad et al., 2016).

Related and unrelated diversity in industries and education are thus calculated at the neighborhood level. This follows from the recent research showing a sharp attenuation of non-market externalities (Arzaghi and Henderson, 2008; Koster et al., 2014; Andersson et al., 2016), which indicates that knowledge spillovers are neighborhood effects rather than regional effects. Considering the firm-level approach and the importance of skilled employees in innovation processes, for example, as intermediators for external knowledge (cf. Cohen and Levinthal, 1989), internal human capital is hypothesized to be positively correlated with firm innovation. In this paper, a firm is classified as innovative if it has introduced a new or substantially improved product (good or service) on the market during the years 2008 to 2010. This follows from the Community Innovation Survey (CIS). The CIS (2010) defines an innovation as new to the firm but not necessarily new to the market. This survey is directed at firms with at least ten employees in both the industrial sector and the service sector. Information from the CIS is thus added to the full population micro-data applied in the previous papers. In the Swedish version of 2010, 4,552 firms responded to the survey, which corresponds to 27 percent of the population. Since the CIS provides a cross-section of firms, ordinary least squares estimation is applied to test for relationships between innovation and related diversity as well as internal human capital.

The results of this paper show that employee education and skills are strongly related to firm innovation. Regarding neighborhood related diversity,
the results show that firms in metropolitan regions are more innovative in places with more related diversity in industries, while firms in rural regions, at least those in the service sector, seem to benefit more from diversity in education. These findings provide an important empirical contribution of the paper. Again, this can be put into perspective by looking at smart specialization strategies (McCann and Ortega-Argilés, 2015), which focus on industry relatedness. The results suggest that such strategies may be relevant for metropolitan regions but less so for rural regions.

The fourth paper Segregation and Individual Employment: A Longitudinal Study of Neighborhood Effects (co-authored with Dr. Lars Pettersson) takes a somewhat different approach. The analysis is undertaken at the individual level, and the main location factor of interest is segregation, which may be regarded as inverse diversity. The purpose of this paper is to analyze how segregation measured in terms of neighborhood characteristics affects the propensity of being employed. In previous literature segregation is identified as a potential source of both positive and negative externality effects. The positive side of segregation springs mostly from social networks, which are more likely to form between individuals belonging to certain groups based on, for example, foreign background. Such networks may work as intermediators for employment through the spreading of information and sharing of contacts (Bayer et al., 2008). On the other hand, spatial and social separation may cause lock-in effects, which isolates already disadvantaged groups and prevents integration into the labor market (Kain, 1968; Massey et al., 1987) as well as society at large. From this perspective, segregation increases obstacles to labor market entry for immigrants in particular.

The empirical analysis in this paper exploits the Swedish full population micro-data, which allows for following a group of individuals from 1990 to 2011. The length of the panel is one strength of the study since neighborhood characteristics have a tendency to change slowly over time. Another strength of the study is that it follows the same individuals during the whole time period, which allows for the introduction of individual fixed effects. This controls for unobserved time-invariant characteristics that influence both where a person chooses to “locate” and whether that person is employed, which is crucial since there is a large self-organizing aspect to residential segregation (cf. Schelling, 1971). The rich micro-data also allow for controlling for observable individual characteristics, such as education, social status, and time spent in the country, which may be important for explaining individuals’ employment status.

This paper provides an important contribution from both a research and a policy perspective. Specifically, the results of the study have potentially strong bearing on both integration policies and urban planning, especially considering the historically large refugee flows to Sweden during the last year (Swedish Migration Agency, 2016). The ability to integrate newly arrived individuals from other parts of the world into the labor market is a very
important feature of any economy. For individuals and households, employment is an obvious factor that determines welfare consumption opportunities. In addition, individuals are the micro-foundation of the economy, which implies that disturbances in the labor market may have long-run consequences for the economic development of an economy as a whole.

The results of this paper show that neighborhood segregation has a significant negative effect on employment, which is driven mainly by males of foreign background. Segregation is also found to be a challenge primarily for metropolitan regions, despite being present in all region types. However, it is not the spatial separation of individuals with different backgrounds that causes lower employment but rather the distress of segregated neighborhoods, in this paper measured in terms of non-employment rates. This indicates that these neighborhoods provide fewer opportunities for labor market integration, which is particularly challenging for individuals of foreign background, who are already disadvantaged on the labor market due to, for example, language, cultural, and social barriers as well as a lack of networks in the Swedish labor market. It is thus important to tackle segregation from an economic perspective and to create opportunities for individuals in both the housing market and the labor market. The integration of individuals with foreign background into society at large thus calls for policies that facilitate job integration as well as housing integration. This may imply a more flexible labor market, strategies for mixed housing at the neighborhood level, and, not least, promotion of higher education. The results of this paper show that higher education is a strong determinant for employment.


