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Charlie Karlsson
Michael Olsson

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By Charlie Karlsson[1] & Michael Olsson[2]

[1]CESIS, Jönköping International Business School, Jönköping, Sweden; Blekinge Institute of Technology, Karlskrona, Sweden; University of Southern Denmark, Sönderborg, Denmark, charlie.karlsson@jibs.hj.se

[2]EFF, University of Skövde, School of Business, P.O. Box 408, SE-541 28 Skövde, Sweden, michael.olsson@his.se, Tel: +46(0)500 448723, Fax: +46(0)500 448599

Abstract: In this paper, we first present how one can create functional economic regions. Then, we elaborate on the economic activity and spatial interaction, which forms functional regions, and the development of the system of functional regions. Our presentation shows that the economy is structured in functional regions, and hence it is important to use functional regions in economic studies, in order to produce correct results, and for regional policy, in order for the policy to be effective. We observe, that the often used NUTS-regions are very large compared to the functional regions. We argue, therefore, that the use of NUTS-regions ought to be replaced by the use of functional regions. This would lead to more reliable results and better policy outcomes.

Keywords: Functional economic region, accessibility, infrastructure, network, regional policy, Europe

JEL codes: R23, R32, R40, R58

1 Introduction

The European Union uses administrative regions in three levels, NUTS-1, 2 and 3, for a) the collection, development and harmonisation of the European Union's regional statistics, b) socio-economic analyses of the regions, and c) the framing of EU regional policies (Eurostat, 2011). According to Eurostat (2011, p. 6) "NUTS 3, which broadly comprises regions which are too small for complex economic analyses, may be used for specific analysis or to pinpoint where regional measures need to be taken". Empirical analyses of spatial issues in Europe are today mainly done using data for the NUTS-2 level, often without any discussion of the choice of analytical level. Certainly, there are variations between the different NUTS-2 regions in Europe. However, there are strong reasons to believe that the variation within the NUTS-2 regions is substantially larger than the between variation, i.e., the NUTS-2 regions lack the internal coherence necessary to be used as units for scientific analyses and for policymaking (Hall & Hay, 1980; Cheshire & Carbonaro, 1995; Magrini, 1999: Cörvers, Hensen & Bongaerts, 2009). For research and policy-making issues, it is essential that the delimited regions exhibit functional similarities, i.e., they must be functional economic regions. However, despite a rich literature on functional regions, the effect on spatial economic analyses and regional policymaking has been minimal.[1]

There is a high probability that the use of administrative regions, such as NUTS-2 regions, in research will produce misleading conclusions and then contribute to an ill-advised policy-making approach (cf., Maza & Villaverde, 2011). Misleading research results will be generated, since the usual assumptions for regression modelling will not strictly hold due to the, from a functional point of view, arbitrary boundaries of the administrative regions (Stimson, et al., 2011). One reason why the policy advices will be wrong is that the different functional economic regions within such administrative regions face very different challenges and, thus, need very different policy responses (Garcilazo, 2011). This implies that the current regional policy efforts in Europe are not focusing the right target and does not have a high enough degree of precision, since they are targeting the NUTS-2 level. The decisions made concerning the planning, distribution and allocation of resources among the NUTS-2 regions are not likely to be the most effective and meaningful compared with the decisions that would be made if the underlying pattern of functional regions was used (Amedo, 1968). We argue that often also the NUTS-3 regions are too large and heterogeneous internally to portray the actual spatial patterns and development of society. The municipalities, on the other hand, are normally too small in spatial terms to be self-contained spatial units and are often closely interlinked with nearby municipalities not least through commuting flows.

Functional economic regions can be described as spatial economic systems, which consist of a number of economically interdependent nodes (centres) of varying sizes and with varying geographical extensions. They resemble the hierarchical spatial arrangement described in the central place framework (Christaller, 1933; Lösch, 1943).

[1] One exception is Sweden, where a substantial number of analyses have been performed using data for functional economic regions (See, e.g., Andersson, Gråsjö & Karlsson, 2007, 2008 & 2009; Karlsson, Andersson & Gråsjö, 2008; Karlsson & Andersson, 2009; Andersson & Klaesson, 2009; Gråsjö, 2009; Grek, Karlsson & Klaesson, 2011; Karlsson & Nyström, 2011; Gråsjö, 2012; Ejermo & Gråsjö, 2012).

Each functional region normally consists of a central node[2], normally a larger city, and a corresponding hinterland of smaller nodes. This structure implies systematic differences between the nodes in the hinterland and the central node in terms of the relative size of different accessibilities. The ratio between a central node's internal and intra-regional accessibility to e.g. human capital is typically much larger than the same ratio for the nodes in the hinterland. This hierarchical structure is likely to alter the magnitude and direction of the spatial dependencies between the different types of nodes. For a central node, the scale of e.g. human capital, in adjacent surroundings is small in relation to its internal human capital resources. Exactly the opposite is true for the smaller nodes in the hinterland. In view of this, it can be expected that the importance of intra-regional accessibility to e.g. human capital is larger for smaller nodes than for central nodes. This suggests asymmetric spatial dependencies within functional regions.

However, it is not sufficient in regional policy making to focus only on the individual functional economic regions. We must also consider the system of functional regions. Within this system, the different functional regions exhibit their patterns of specialization, which have emerged due to changes over time in the division of labour between regions and the pertinent specializations. Thus, functional regions are to varying degrees connected with other functional regions via flows of goods, services, capital, information and knowledge and the migration of labour and firms. The specialization patterns that have emerged are partly a function of the costs of transportation and information transfer between different functional regions. These costs are a function of the capacity and quality of the pertinent infrastructure, transport and information systems. The capacity and quality of these systems only change slowly over time. However, when certain critical levels have been achieved through investments in the systems there might be "catastrophic" structural changes in the specialization patterns. The possibility of such structural changes poses special analytical problems and researchers might have problems with providing regional policy makers with secure analytical results. Nevertheless, investments in interregional infrastructure, transport and information systems are a necessary complement to a place-based regional policy focusing individual functional regions.

Against the above background the purpose of this paper, is to make a case for the following two claims:

1. The proper level for analyses of regional economic issues as well as for regional policy making is the functional economic region.

2. A place-based policy focusing different functional regions with their various development problems must be complemented with a network-based policy targeting the infrastructure networks connecting the different functional regions.

This paper is organized as follows: In Section 2 we describe the characteristics of functional economic regions and how to construct them. In Section 3 we describe the economic activity and development in a functional region. Functional regions are re-

[2] There also exist some functional economic regions with two or more central nodes of almost equal size, where no node is big enough to dominate fully.

lated and part of a larger system. We describe the system of functional regions in Section 4. In Section 5 we argue that functional regions are the appropriate spatial unit for studies and for policies. In the final chapter, we present our conclusions, discuss the implications of the results, and suggest future studies.

2 The characterization of functional economic regions

Our starting assumption is very simple: We assume that the economic geography of a country consists of non-overlapping but contiguous functional economic regions, which contain agglomerations of varying sizes from the very small to the very large and their associated hinterlands. Functional regions exist because certain market transactions and certain extra-market information and knowledge transfers are less costly when carried out between actors inside a functional region than when they take place between actors in different functional regions (cf. Cheshire & Gordon, 1998). Thus, a functional region is characterized by its agglomeration of activities and by its intra-regional transport infrastructure and established economic interaction networks, facilitating a large mobility of people, products and inputs within its borders. We can say that a functional region is an integrated economic system defined by the interaction which takes place in its networks, e.g. commuting, communication, decision-making and distribution of goods and services (Karlsson, et al., 2009). A functional region has a much higher frequency of all types of interactions within its borders than with other functional regions. All types of interactions give rise to interaction costs and the borders of functional regions are determined by where these interaction costs start to increase sharply.

It is a common assumption in regional economics that products vary with respect to the contact or interaction intensity associated with their input and/or output transactions (von Thünen, 1826; Lösch, 1943; Hirsch, 1967). For products with standardized characteristics and routine transaction procedures, little or no direct contact between buyer and seller is necessary. Moreover, when the same supplier and the same customer repeat the same delivery, the interaction between these two actors can be routinized, and hence the contact intensity goes down, causing transaction costs to decline. However, many products are traded under complex and contact-intensive transaction conditions, which may involve many different transaction phenomena, such as inspection, negotiations, contract discussions, legal consultation and documentation of agreements. Such products may themselves be complex and have a rich set of attributes that may be varied, but the basic thing is that, from a transaction point of view, they are not standardized, and the interaction procedures are not routine procedures. A special case of contact-intensive transactions is products that are customized and designed according to the specifications by the customer in a process of customer-supplier interaction. Thus, it is obvious that the contact-intensity associated with selling and delivering different products varies considerably.

Another common assumption in regional economics is that interaction costs are much lower for transactions within a functional economic region than between functional regions. This implies that contact-intensive products can be claimed to have distance-sensitive transaction costs and that these geographic transaction costs rise sharply when a transaction passes a border between functional regions (Johansson & Karls-

son, 2001). This also implies that products can be distance-sensitive with respect to input transactions. Similar arguments apply to the labour market in the sense that individuals (firms) search for jobs (labour) mainly inside the functional region. The working life clearly is contact intensive. As a result, the interaction frequency associated with distance-sensitive products supplied in a given functional region including labour can be assumed to decrease with increasing time distance from the region's centre (Holmberg, Johansson & Strömquist, 2003). Actually, it is a general result from spatial interaction theory that the interaction intensity is a decreasing function of the time distance between origin and destination (Sen & Smith, 1995).

A third common assumption in regional economics is that the concept of market potential can be used as a means to describe economic concentration in functional economic regions and the opportunities of making contacts within and between functional regions (Lakshmanan & Hansen, 1965). There are several strong reasons for making a precise distinction between the internal and the external market potential of a functional region. The delineation of a functional region is in a fundamental way related to the identification of its internal market potential. The internal market potential is a measure of the market opportunities existing inside the borders of a functional region.

For each type of product in each functional economic region, it is possible to divide the total market potential into the internal (intraregional) and the external (interregional) market potential. Firms wanting to supply distance-sensitive products must find a sufficiently large demand for their sales inside the functional region where they are located. Since internal economies of scale in principle prevails in all firms but to a varying degree, the internal market potential must exceed a certain threshold if firms supplying distance-sensitive goods shall be able to make a profit, i.e., 'economic density' matters (Ciccone & Hall, 1996; Karlsson & Pettersson, 2005). In addition to market potential, a firm obviously has to consider the level of competition.

The size of the internal market potential of a functional economic region is, among other things, a function of its transport infrastructure provision. Infrastructure for physical interaction has the role of offering high density combined with low transaction costs, i.e., a high accessibility (Johansson, 1996). A high internal market potential implies that suppliers have a high accessibility to customers and that producers have a high accessibility to suppliers of specialized inputs as well as to households supplying specialised labour inputs.

Transport infrastructure has two fundamental roles (Lakshmanan, 1989): (i) it influences both the consumption and the production possibilities of societies, and (ii) it is intrinsically a collective good in the sense that it is common to both households and firms. Thus, transport infrastructure in a basic way influences the size of the internal and the external market potential of a functional economic region by (i) extending its spatial interaction links, and (ii) creating intra- and interregional accessibility. Infrastructure also extends over time through its durability, which creates sustainable conditions for production and consumption for extended periods.

2.1 The functional urban region

Many functional economic regions are actually functional urban regions, a region around a city (or sometimes more than one city in the case of polycentric functional

urban regions). The idea of a functional urban region has a place in most models of urban economics. In "New Urban Economics", for example, an urban region is identified by deriving increasing commuting costs from increasing distance from the city centre, which hosts most of all workplaces in the urban region (Fujita, 1989). A useful explanation of the concept has been provided by Robson, et al. (2006, 1):

"City-Regions are essentially functional definitions of the economic but also of the social 'reach' of cities. The aim in defining them is therefore to identify the boundaries of those areas in which a majority of the population see the core city as 'their' place – in which they may work, shop for certain types of goods, visit for entertainment and leisure pursuits, and with which they identify."

In the literature, functional urban regions have been divided into different zones according to employment, population, settlement or accessibility characteristics. In the simplest case, only 2 zones have been identified: i) the urban core or the city centre and ii) the hinterland or the ring. How to define and delimit these zones have been discussed intensively in the literature (see e.g. Hall, et al., 1973; Hall & Hay, 1980; Drewett, et al., 1983; Cheshire & Hay, 1989). Of course, there is "fuzziness and overlap at the boundaries of many City-Regions; and the degree of self-containment is likely to vary for different kinds of activities" (Robson, et al., 2006, 1). This implies that different forms of flows and activities, which only partly overlap, define the cores and rings.

Functional economic regions allow for a division of labour between different areas within the defined spatial market. The different areas within a functional region have different specializations. This includes work districts and residential districts but even if their characteristics are quite different, they are strongly linked and dependent upon each other. Similarly, the different work districts have a different specialization ranging from knowledge-intensive business services and headquarter functions in a highly dense central business district to land-intensive and transport accessibility-dependent production located in less dense surrounding districts that offer lower land prices and higher accessibility in the freight transport system and for labour but at the same time have a good accessibility to the agglomeration advantages offered by the central business district. Residential districts on the other hand show segregation between rental and owner-occupied flats and apartments in multifamily houses in districts partly with a central location and often larger owner-occupied single-family houses in less dense neighbouring districts. Thus, modern functional regions are not characterized by the traditional duality between centre and hinterland with suburbs, but by many centres of varying size and with varying specialization, which are connected via different complex networks (van der Laan, 1998).

2.2 The local labour market

There is a rather rich literature on functional economic regions (sometimes referred to as local labour market regions, daily urban systems, commuting regions or travel-to-work areas) and their delimitations.[3] Already von Thünen (1826) analysed the loca-

[3] See e.g., von Thünen, 1826; Christaller, 1933; Lösch, 1943; Fox & Kumar, 1965; Berry, et al., 1969; Goodman, 1970; Micklander, 1971; Hall, et al., 1971; Brown & Holmes, 1971; Hay & Hall, 1978; Ball, 1980; Hemmasi, 1980; Hall & Hay, 1980; Spence, et al., 1982; van den Berg, et al., 1982; Coombes, Green and Openshaw, 1986; Cheshire & Hay, 1989; Noronha & Goodchild, 1992; Killian & Tolbert,

tion of the production of different kinds of agricultural production on a plain surrounding a single central market place. The relationship between locations and the formation of markets, where the types of economic activities represented in different locations was taken up by Christaller (1933) in his central place theory and by Lösch (1938) in his analysis of the nature of economic regions.[45]

It is only geographical classifications based upon an analysis of labour market behaviour that can give the necessary insights into critical issues of regional performance in terms of labour force participation, employment, unemployment, innovation, productivity, growth and general welfare. Thus, any meaningful socio-economic geography must be defined by socio-economic features of space. The theoretical basis for demarcating regions based on commuting behaviour is outlined, for example, in Watts, et al. (2006).

A labour market region is conceived as a geographical area within which there is a high degree of interactivity in terms of commuting by residents. Its geographical extension is largely a function of the pecuniary and psychological costs of daily travel to work. Thus, it is the appropriate scale to capture not only the interplay between labour supply and demand but also many other central aspects of the behaviour of households but also of firms. The daily activities of households including work, shopping and service consumption tend to be performed rather close to their place of residence. Households that change job and/or place of living mostly do that within the labour market region where they are located. Firms primarily hire workers living relatively close to the firm, buy most services from service firms located nearby and often sell their products in close proximity. This implies that short-distance spatial interaction dominates for most households and firms. For each centre of economic activities, there exists a hinterland dominated by interactions with the centre. A labour market region and, thus, a functional economic region, consists of one centre or sometimes more than one centre and the appurtenant hinterland (Karlsson, 1994). Such a functional region is characterized by a high frequency of intraregional economic interaction (Johansson, 1998), such as intraregional trade in goods and services, labour commuting, traffic flows, financial flows, newspaper circulation and household shopping (Vanhove & Klaassen, 1987). In essence, a functional region is a system of highly connected smaller and larger places where the borders are defined by where the major flows change direction, i.e. they mirror the major linkages and interconnections of economic activities.

The extension of the spatial labour markets result from the costs of commuting, the standard of the transport infrastructure, the costs of changing jobs and place of residence and the functioning of the information networks (cf. Hasluck, 1983). Employers and workers in a labour market region are assumed to be well informed and able to

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1993; Johnston, 1995; Baumann, Fischer & Schubert, 1996; Tolbert & Sizer, 1996; Casado-Díaz, 2000; Andersen, 2002; Flörkemeier, 2002; Newell & Papps, 2002; Antikainen, 2005; Karlsson & Olsson, 2006; Mitchell & Watts, 2010.

[4] Interestingly, rather few of papers on functional economic regions refer to the fathers of spatial economics and their theories on economic regions.

[5] One could have imagined that the contributions by Christaller and Lösch should have stimulated attempts to delineate functional economic regions at higher levels than the labour market region, such as market areas for universities, airports, etc. but there seems to be few such contributions.

respond much more quickly to changes in internal market conditions than to changes in market conditions in other labour market regions.

There exist two main definitions of local labour market regions based upon travel to work behaviour (Robson, et al., 2006):

1. Exhaustive and non-nodal: This is a bottom-up approach based on setting minimum levels of travel to work self-containment and minimum employment levels for identifying functional economic regions. This is an exhaustive approach, which allocates all localities to a city region.

2. Non-exhaustive and nodal: This is a top-down approach. The centres of these regions are predefined nodes and it is then simply a case of identifying which other areas have minimum levels of travel to work flows into these nodes as the criteria for being considered a part of the city centre or the hinterland of their functional economic region. Various criteria are used to predefine the nodes and to identify critical levels of minimum travel to work flows from other areas.

The basic characteristic of a functional economic region is its integrated labour market, in which intra-regional commuting as well as intra-regional job search and search for labour is much more intensive than for their interregional counterparts (Johansson, 1998b). The borders of a labour market region are a good approximation of the borders of a functional region. There exist alternatives to the labour market approach to define functional regions, including:

1. Housing market definitions that examine patterns of residential mobility or housing prices in order to define local housing markets.

2. Economic activity-based definitions based on inter-firm business linkages.

3. Service-district definitions based on defining service area hinterlands for shopping and other major services.

4. Administrative area definitions based on convenience and public service delivery.

5. Transport data as a proxy for travel to work.

3 Economic activity and development in functional economic regions

The purpose of this section is to try to understand the economic activities and development in functional economic regions and to do that we must understand the factors that are driving the location and clustering of firms and households. Functional regions differ from each other in terms of their economic milieus due to the heterogeneity of natural conditions and historical investment, migration and development paths, which have nurtured dissimilar conditions for economic specialization. The regional economic milieu comprises all those location attributes that are durable (i.e.

fixed or slowly changing), that the individual firm (household) cannot control, and that are not traded other than as land attributes and that influence firms' production (households' consumption) activities (Johansson, 1998a).

The dynamic processes that over time reshape the economic milieu of a functional region are driven on the one hand by external forces, and on the other hand, by adjustment, development and investment processes within the region. The dynamics of these processes are often extended in time, due to the inertia associated with the transformation of regional resources. This inertia, which differs in strength between functional regions, gives each functional region its own identity but also implies that their economic structure normally only changes gradually and at a slow pace. Of course, there might also be rapid changes in the economic structure of a functional region, for example, when a major employer or group of major employers decides to close the operations in the region. Smaller functional regions, but also larger functional regions with a strong industrial specialization are vulnerable in this way. The varying economic milieu of functional regions influences economic agents and their behaviour in three major ways:

1. The production conditions offered different industries, which imply that each functional region has a specific set of durable location attributes that influences the productivity and cost structure of firms in a non-uniform fashion.

2. The attractiveness for different types of economic agents, which influences the in- and outmigration of households, firms, etc.

3. The innovative capabilities, which influence the generation of new knowledge, new technology and innovations.

3.1 Resources and development

The traditional approach to explaining the location of production started with Ricardo's suggestion that different regions dispose of different technologies. This was later transformed into the idea that it is the relative abundance of productive resources trapped in different functional economic regions that matters (Ohlin, 1933). We can describe this approach as a resource-based theory of location and clustering (and trade). This resource abundance argument has later been further exploited in models that focus on localized knowledge as a production factor (Andersson & Mantsinen, 1980; Romer, 1990). Spatial variations in taste could also play a part in the decision to locate production.

The critical 'pre-located' resources consist of i) natural resources, and ii) other resources that change on a slow time scale. The second type of resources include the supply of infrastructure in the form of facilities and networks, R&D organizations, existing production capacities with specific techniques and the supply of different immobile and semi-immobile labour categories with their specific skills and the economic milieu in general (Andersson, Anderstig & Hårsman, 1990). An interesting aspect of this second type of resources is that they probably affect the development activities of firms in a functional economic region more than their normal output activities. Thus, they constitute stimuli to innovations and renewal processes in general. In addition, the size of a functional region can be seen as a 'pre-located' resource, be-

cause a larger region with more people and more firms offer a richer set of potential contacts. Larger functional regions also offer special advantages for firms supplying products that require frequent contacts between seller and buyers. In this sense, the size of the intra-regional market demand constitutes a regional resource, which can be assumed to change at a slow time scale.

The traditional approach examines how firms and household adjust their location to the spatial patterns of pre-located resources. Modern resource-based models often emphasize the supply of knowledge-intensive labour as the major location factor. The durable capacities generate comparative advantages in the sense of Ricardo and influence the potential specialization profiles of a functional economic region. Although these characteristics are more or less exogenously given in the short and medium term, a major part of the durable characteristics (except natural resources) change gradually over time on a slow time scale and are to a large extent created by investment and migration processes. Firms and households on the other hand adjust their location, and the scale, and the scope of their activities on a faster time scale. This implies that a short-term location equilibrium is only a temporary phenomenon that applies as long as there are no major changes in the location of the resources that change on a slow time process (Johansson, Batten & Casti, 1987).

3.2 Scale and development

Researchers started to challenge resource-based models more than three decades ago and advocated instead scale-based models (Krugman, 1979, 1980 & 1981; Dixit & Norman, 1980; Lancaster, 1980; Ethier, 1982; Helpman, 1984), which actually was made already by Ohlin (1933). This second type of models explain location and clustering in (and trade between) functional economic regions in a context of scale economies internal and external to firms and intra- and interregional market potentials, where the interdependence between market potentials and scale economies are essential. In the short- and medium-term, the properties of markets are durable phenomena, which create comparative advantages in the pertinent functional regions. It is obvious that in order to understand the growth (and decline) dynamics of functional regions, there is a need to merge the two approaches. One possible approach to do this is to associate i) the resource-based advantages with the input market potentials in each sector, and ii) the scale-based advantages with the customer market potentials of each sector (cf., Holmberg, Johansson & Strömquist, 2003).

The realization of scale economies, and the associated potential of division of labour (i.e., decomposition of production), and specialization are intrinsically related to the market size (Stigler, 1951; Beckmann, 1958; Tinbergen, 1967; Kaldor, 1970; Arrow, 1979). When the decomposition takes place within a firm, the firm takes advantage of internal economies of scale, and when the decomposition leads to outsourcing of production, the firm takes advantage of external economies of scale. Internal economies of scale are technological phenomena related to individual firms and imply that the productivity increases (and the unit costs decreases) as output gets larger. They may be related to the existence of one or several productivity-enhancing indivisibilities (fixed-cost factors), such as indivisible equipment, knowledge resources including patents, brand names, material and non-material networks or set-up costs or learning how to do it (Koopmans, 1957), i.e., a ‘catalyst’, which must be present in the production process without being used up (Krugman, 1990). The absolute size of the

fixed costs does not matter. Instead, the size of the fixed costs should be related to the size of the potential demand (Chamberlain, 1993; Krugman, 1991).

In modern theories of firm location, internal economies of scale and the size of the internal and external market potential of functional economic regions are used as the principal factors explaining the spatial location of firms. Internal economies of scale are essential in all models, which emphasize the role of the variety of outputs and inputs, respectively. Firms with internal economies of scale at a given level search for functional regions with a large enough market potential to make it possible to produce at a profit given the level of economies of scale. Some types of goods and many types of services are connected with large geographical transaction costs, which implies that it is the intra-regional market potential that determines whether profitable production is possible in a given functional region or not. Thus, it is essential to classify products with regard to their distance-sensitivity, where transaction costs are concerned. Based on such an approach, one can specify specific categories of products with a potential to locate in functional regions with different internal market potentials.

The location of firms in different functional economic regions cannot be explained solely by internal economies of scale. Of equal importance is the existence of external scale economies, which are vital for a sustainable development of functional regions as agglomerations. A firm operating under constant returns to scale can benefit from positive external economies from the output of other firms in the same functional region, i.e., from external economies of scale (Chipman, 1970). Already Ohlin (1933) developed a scheme for analysing different kinds of scale economies. In particular, he focused on how individual firms are affected by the co-location of other firms. In his scheme, he distinguished between four kinds of scale economy phenomena:

1. *Internal economies of scale* associated with the production technique or the production conditions of the individual firm.

2. *Localization economies*, which affect the individual firm as an influence from the industry to which it belongs.

3. *Urbanization economies*, which arise from the size of the economy in the functional economic region, and that, are external to the firm and its industry.

4. *Inter-industry input linkages* of input-output type, where proximity to suppliers of intermediate inputs reduces their price.

Localization economies occurs when several firms producing similar products, i.e. belonging to the same industry, are located to the same functional economic region. Localization economies are vital to understand specialization and the growth (and decline) dynamics in small and medium-sized functional regions (Johansson & Karlsson, 2001). The importance of localization economies was stressed already by Marshall (1920). Generally, localization economies play a central role in many models in urban and regional economics as well as in models of spatial product cycles (Mills, 1967; Hirsch, 1967; Henderson, 1986). According to Marshall's theoretical scheme, there are three sources of positive industry-specific effects from the agglomeration of firms in the same industry in a functional region: i) non-traded local inputs, ii) regional skilled-labour supply, and iii) information spillovers.

Non-traded local inputs may be considered as distance-sensitive inputs. Owing to high geographic transaction costs, these inputs are more expensive when delivered from sources outside the functional economic region. This implies that proximity becomes an advantage when firms in the same industry are co-located, since the concentrated demand for these inputs from the pertinent industry also attracts input suppliers of various kinds to locate in the same functional region. These input suppliers have their own internal economies of scale. Thus, it is important for them to have access to a sufficiently large demand within a functional region, since their products are distance-sensitive. Co-located firms in the same industry in a functional region may provide a large enough demand for making it profitable for input producers to locate there. The desire of specialised input suppliers to be in the same functional region as their customers is determined by a combination of frequent interaction with their customers and distance-sensitive transaction costs.

The second source of positive industry-specific effects from the co-location of firms in the same industry in a functional economic region is related to the labour acquisition costs of firms. In a functional region where a large share of the labour force already have specialized industry-related skills, the costs for a firm in the actual industry to recruit such labour normally are lower than if the same labour should be recruited from another functional region. Both search and training costs can be assumed lower when the labour pool with specialised industry-related skills is large in a functional region. At the same time, co-located firms in the same industry in a functional region may attract to the region a rich variety of labour categories with skills relevant for the industry in question.

According to the above arguments, proximity to specialized input suppliers and specialized labour supply implies that these inputs can be acquired at a lower total cost for given quality levels, when firms in a given industry are co-located to the same functional economic region. Because of this, the described phenomena belong to the family of pecuniary externalities.

The third source of positive industry-specific effects from the co-location of firms in the same industry in a functional economic region is the information and knowledge stock available among the co-located firms, which has the character of semi-public good available in the actual functional region. This phenomenon has the character of a non-pecuniary or technological externality, since it brings benefits that are not provided at a price, except in the form of land prices. Information and knowledge are spread among the co-located firms in the same industry in a functional region, because in such an environment with face-to-face contacts it becomes prohibitively costly to keep all information and knowledge private. Hence, some proprietary information and knowledge will spill over, because of business as well as private interaction between people attached to the actual industry in the functional region. The information and knowledge that spills over may concern areas such as production techniques, product attributes, input suppliers, R&D results, customers and/or market conditions.

Urbanization economies[6] occurs in large functional urban regions hosting many different and interacting industrial clusters offering both diversity and a high degree of specialization due to the size of the market. Large functional regions offer agglomeration economies, which provide a creative milieu (Andersson, 1985), a diversified supply of producer services, human capital, and intra- and inter-regional information and knowledge flows. For the most part, large functional regions offer a more diverse supply of markets than smaller functional regions (Hacker, Johansson & Karlsson, 2004). This reflects among other things differences in geographic transaction costs among goods and services. Profit-seeking firms cannot supply distance-sensitive goods and services in functional regions where the demand is too small to cover the fixed costs.

The theoretical background is the following: Diversity in the set of regionally produced consumer goods or producer inputs can yield external scale economies, even if all individual competitors and firms earn normal profits. The size of a functional economic region in terms of aggregated purchasing power determines the number of specialized local consumer goods and producer inputs, given the degree of substitutability among the specialized local goods in consumption and among specialized inputs in production:

"A larger city will have a greater variety of consumer products and producer inputs. Since the greater variety adds to consumer well-being, it follows that larger cities are more productive, and the well-being of those living in cities increase with their size. This is true even when all firms in these cities earn a normal rate of profit." (Johansson & Quigley, 2004, 170)

There are two well-known models, which deal with the advantages of a diversified urban economy. The first model focuses on urbanization economies in general, such as consumers' taste for variety and, in addition, the productivity of specialized production factors. The second model is quite different: the proximity and linkages of firms in an agglomeration enhance their productivity. Here the perspective is forward and backward linkages among economic agents such as firms.

Thus, large urban functional regions have quite different specialization opportunities compared to smaller functional regions, since the demand for diversity and variety favours the location of economic activities and households in large urban functional regions. Large home markets in conjunction with high accessibility to external markets enable many large urban functional regions to develop specializations, i.e. clusters, in many different industries. Firms in the same cluster may represent different stages in the production chain and also industries offering supplementary services.

Both input and customer market potentials tend to vary with the size of functional economic regions. This makes it possible to combine resource-based and scale-based models to explain the location and the co-location of firms. We can assume that the larger the functional economic region, the larger the potential to combine internal and external scale-economies and the larger the economic density. In particular, for large functional economic regions, scale economies imply a location advantage with regard

[6] However, there are factors limiting the growth of cities. Otherwise, cities would grow continuously. There are costs which rise with city size, most obviously prices (space in particular), and some external costs like congestion and pollution. Also probably, crime rises with city size.

to all products with a thin demand and firms supplying such products will mainly be found in such regions. Thus, large functional economic regions tend to become characterized by economic diversity combined by a high degree of specialization within the different firms. However, scale economies constitute an equally important phenomenon for firm location and co-location in functional economic regions of all sizes. Smaller regions can develop a specialization, i.e., a cluster, in a self-organized way. However, in this case the development is limited to a set of closely related products with low geographical transaction costs in the same industry supported by localization economies.

3.3 History and development

The location of a firm in a functional economic region of any size may release a set of self-reinforcing circular processes, which in an endogenous change process gives rise to a co-location of firms in the same industry and/or the location of supplier and/or customer firms to the industry through 'cumulative causation' (cf. Myrdal, 1957). This form of positive feedbacks is in general constrained by i) the development of the demand in the functional region and in its external markets, and ii) the existing capacities in the form of built environment, accessibility based on transport systems, production capacities and labour supply. For certain activities, these constraints may not be binding, whereas other activities require adjustments of the durable capacities. The market potential can be assumed to adjust on a faster time scale than the durable capacities.

In the longer-term perspective, the capacities and the economic milieu of functional economic regions adjust through a system of coupled feedback links. The interaction between scale economies and durable regional characteristics has the same nature in functional regions of varying sizes, although external linkages to other sometimes distant functional regions are more vital for smaller regions. For small and medium-sized functional regions, the adjustments of durable capacities can be assumed rather specific with regard to the narrow set of industries, which form the specialization nexus of such regions. This implies that there is always a risk that, in particular, medium-sized and smaller functional regions may develop a very specialized material and immaterial infrastructure, which in the long run can be an obstacle to the over time necessary economic structural change (Johansson & Karlsson, 1990). Using the German Ruhr area as an example, Grabher, 1993, 256) illustrates how an earlier innovative large economic milieu may lose its innovativeness: "The initial strength of the industrial districts of the past – their industrial atmosphere, highly developed and specialized infrastructure, the close inter-firm linkages, and strong political support by regional institutions – turned into stubborn obstacles to innovation." Hudson (1994) draws the same conclusion based on analyses of a large number of industrial regions in Europe.

We now have to come back to the effects of durable regional characteristics, such as infrastructure and production factors, which have a fixed or semi-fixed location across functional economic regions. Durable characteristics can be divided into i) local and external market potentials for the region and ii) other durable regional capacities (Johansson & Karlsson, 2001). The latter consists of i) the regional supply of different labour categories, ii) existing production capacities with their different vintages of production techniques, iii) R&D organizations, iv) universities and colleges, and v)

material infrastructures in the form of facilities and networks (Johansson, 1995). These durable capacities and their pertinent quality generate comparative advantages in the Ricardian sense and influence the specialization profile of functional regions. Although these durable characteristics are more or less fixed in the short and the medium term, a major share of the durable characteristics changes gradually over time mainly due to investment and migration-like processes. These processes are partly driven by decisions by households and firms, but political decisions in many cases play a major role in reshaping the durable regional characteristics over time.

Turning to the local and external market potentials of regions, we can observe that in a short and medium term perspective the properties of these market potentials are also durable regional characteristics, which create various comparative advantages in the pertinent functional economic regions. The dynamics of the interdependence between market potentials and economies of scale is essential to understand how functional regions develop over time. The interaction between market potentials and the location of firms with scale advantages is indeed intriguing. Firms with internal economies of scale are attracted to locate in functional regions with a high internal and/or external market potential given that the costs to interact with the customers are not too high and given the capacity and quality of the pertinent regions' durable resource endowments. Sketching how the location of an individual firm may release the location of firms in the same industry or supplier firms for this industry can be done by referring to i) a firm's local and external customer market potential, ii) a firm's input market potential, and iii) a firm's labour-input market potential. The idea that firms need to consider both output and input markets potentials goes back to Weber (1909), who acknowledged the interaction costs between supplier and customer as the factor influencing where firms locate.[78] In this framework, an individual firm considers how its location affects the costs of inputs to its production (i.e. supply) activity, and it may also consider how its delivery price is influenced by the accessibility to customers buying its output. In a Weber-type framework, it is possible to consider how increasing distance to input suppliers raises input costs, and how increasing distance to customers reduces net returns from sales.

The distance between seller and customer play an equally important role in the von Thünen (1826) framework. In this framework, the major idea is that the distance sensitivity varies across products, which generates a location equilibrium with differentiated land values.[9] The idea that products vary with regard to distance sensitivity can be integrated in Weber's framework where the location of firms is affected by the spatial transaction costs in relation to input supply and output demand (Johansson & Paulsson, 2009). Such integration makes it possible to introduce two basic externalities that affect the location processes in functional economic regions: i) the input-demand externality and ii) the output-demand externality. The input-demand externality, which is based on the co-location of a firm and its suppliers of distance-sensitive inputs (Marshall, 1920; Fujita & Thisse, 2002), implies that input costs fall as input demand grows. The output-demand externality has been emphasized in models in which

[7] This observation becomes very profound when we acknowledge that the location of input suppliers and output customers may change due to individual location choices of firms and households (Johansson & Forslund, 2008).
[8] Such firm locations can be seen as the initiation of new product cycles.
[9] The ideas from Weber and von Thünen have been integrated in contributions by Predöhl (1928), Isard (1951), Moses (1958) and Beckmann & Puu (1985).

production features internal scale economies (Krugman, 1990; Fujita, Krugman & Venables, 1999) and implies that unit costs of firms supplying distance-sensitive products fall as output demand grows.

Of course, firms vary in terms of number and location of customers. Some firms only sell to customers in the own functional economic region. Others sell to many customers spread over many functional regions. These circumstances together with the firm's own location affect the customer interaction costs, which include transport and transaction costs. When a firm sells to customers in many different functional regions, the pattern of customer location will adjust on a slower time scale than what applies to the selling firm itself. Over time the patterns of customer location tends to lead to a spatial concentration of demand through a gradual path-dependent process – a core element in the so-called "new economic geography" (Fujita, Krugman & Venables, 1999). On the other hand, functional regions, where many firms want to locate develop a large internal market potential. This observation is further strengthened, if we note that for many activities internal and external scale economies co-exist.

The location decisions by firms including the decision to stay in the current location is also influence by prevailing input market potentials including the costs of interaction with suppliers, where the interaction costs include the transaction costs that affect the input prices (McCann & Shefer, 2004). These costs vary across alternative functional economic regions and even within functional regions. Interaction here might include R&D collaboration with input suppliers but also with other knowledge providers. The location patterns of input suppliers may change more slowly than the location of the input-buying firms, but the time scales are not necessarily very different.

If we analyse the specialization of functional economic regions on a slow time scale, the size (and composition) of their internal and external market potentials become variables that evolve in a dynamic process. Similarly, on a slow time scale we can observe how the specialized labour supply of different functional regions gradually adjusts in process that is interrelated with the changes in the economic specialization of these regions.[10] In a sense, these insights into this type of integrated cumulative endogenous courses of events are not new. They can be traced back to the contributions by Marshall (1920), Myrdal (1957) and Kaldor (1970). The interaction infrastructure will function as a support factor in these change processes.

With the above view of the world, the location of a particular industry to a particular functional economic region is history-dependent, due to the prevalence of multiple equilibria. This also implies that policy matters. However, and this is a critical observation, it is by no means certain that policy always can change the direction and speed of the on-going dynamic processes. Once a specialization process is initiated, for whatever reason, this specialization pattern tends to become "locked-in" by the cumulative gains from trade and increased specialization. Thus, there is a strong tendency towards "path dependence" in the specialization processes of functional regions as well as their patterns of trade specialization.

[10] It is possible to analyse how the location of the individual household changes when the location of firms and thus jobs based upon i) its job market potential, ii) its housing market potential, and iii) its consumption market potential.

4 The system of functional economic regions

The purpose of this section is to highlight the relation between functional economic regions. Functional regions are not only integrated labour markets. Depending upon their size and their hierarchical position in the national urban system, they exhibit different specialisations in terms of the extension of their supply of central place products (Karlsson & Nilsson, 2002). On top of that, they also exhibit an industrial specialization that mirrors not least their export base. Thus, we can say that functional economic regions at each point in time have two major types of specializations, which of course changes over time. Noyelle & Stanback (1984) presented a broad typology that can be used as a first approximation of the specialization of functional regions:

1. Diverse service regions
2. Specialised service regions
3. Manufacturing regions
4. Consumption regions.

Some researchers challenge the notion of a hierarchy among functional economic regions in terms of their functions (Camagni, 1993; Meijers, 2007). However, this is done without a strong theoretical and empirical support. These researchers instead argue for what they call a network model (Camagni, 1993; Batten, 1995). Interestingly, Meijers (2007) claim that the network model hold most for polycentric urban regions, i.e. a group of rather similar-sized politically discrete cities, separated by tracts of open land, functioning economically as a single urban unit. Thus, the network model concerns mainly what is a special case. We see this as a misuse of the network model. Certainly, we need a network model but not a restricted one (cf. Hohenberg & Lees, 1985). It is obvious that hierarchical relations between functional regions constitute only a partial understanding of the relations between functional regions (cf. Taylor, Hoyler & Verbruggen, 2010). To understand the relationships between the functional regions in a system of functional regions it is necessary also to consider the distinctive and separate 'horizontal' relations.

Actually, we cannot understand the spatial development in Europe the last 1,000 years without applying a network model. Already Pirenne (1936) claimed that it was lower transport costs due to improvements in the transport system that made it possible for European regions to start specialising in the production of agricultural goods and "city" goods, respectively, in medieval times. Since the latter type of production does not need a large supply of land, it was natural that a concentration of the production of "city" goods took place at the junctions of the transport system. Mees (1975) in his analysis showed that Pirenne's logistical hypothesis, i.e., lower transport costs, is the most probable explanation to the emergence and rapid growth of European cities in medieval times.[11] Also later changes in the urban system in Europe can be related improvements in different transport systems that has led to lower transport costs (Andersson, 1986), which has induced firms and households to change their location and to agglomerate.

[11] The critical role of transport infrastructure for economic development in quantitative and qualitative, i.e. structural, terms has also been stressed by von Thünen (1926), Heckscher (1935) and Schumpeter (1954).

With the successive lowering of transport costs has followed very substantially increased trade flows. Exports and imports have played and still play a critical role for the development of functional economic regions by continuously stimulating the renewal of the regional production system (cf. Jacobs, 1969 & 1984).

Over the centuries the goods transport infrastructure has been complemented by new infrastructures for the transport of people, information and capital. Thus, the development of functional economic regions and the urban system can certainly not be understood only by analysing the forces operating within functional regions. We must also consider the effects of the flows between different functional regions of people, goods, services, information and capital for the double specialization and the competitiveness of functional regions. Furthermore, from a medium and long-term perspective we must also consider the effects of various types of interregional infrastructure investments for these flow patterns. Unforeseen changes in factor and goods prices, caused by e.g. negotiations and exchange rates, also lead to structural change.

The problem here is that it is difficult to forecast the effects of improvements of infrastructure links. When a link that connects two functional economic regions with different resource profiles, there will emerge integration advantages in terms of a larger total common output due to an improved division of labour. As long as the costs of the link improvement are lower than the value of the integration advantage, it is profitable to make the investment.

Unfortunately, many studies of economic integration build upon a comparative statics approach. Such methods imply that non-dynamic models are used, where the different connections are studied using static methods developed based upon conditions that only hold for short time periods. Most models for supply and demand in markets are constructed that way. Traffic models of gravitation type are also static and used to compute the effects of for example changed geographical population distribution, changed travel and transport costs or changed travel and transport times. Both the supply and demand models and the gravitation models build upon a judgement that marginal changes in the basic conditions give rise to marginal effects. However, this assumption does not hold for infrastructure projects that fundamentally change the scene or create very new rules of the game.

Some link improvements may play a critical role in the sense that it generates qualitatively different effects then earlier link improvements. Such a link improvement that sometimes might be quite small may generate effects at a substantially higher systems level than other earlier investments with similar costs. In this case, the evolutionary relationship between infrastructure and economic development become revolutionary. This implies that there is a need to use a more structural analytical method, i.e. a genuine dynamic model for the specialization of production, and thus, for trade with and transport of goods and services and consequently also of human beings.

When the critical link investment has been made synergy effects, i.e. system wide economic development effects, emerge. This implies that the original general equilibrium structure is substituted by a new and higher general economic development level. When such a transformation takes place, the whole economic system goes into a phase of disequilibrium with a rapid structural change, which affects many functional economic regions. Thus, when the frictions for trade between functional regions falls

below a certain critical level due to the critical link improvement the economic structure within the system of functional regions will now shift to a higher specialization level within individual functional regions with new and larger trade, quantitatively larger travel and transport flows and larger incomes in what is now a more integrated system of functional regions.

One theme in this literature of particular importance, which goes back to Berry, Goheen & Goldstein (1969), concerns centralization and decentralization within functional urban regions. Research on functional regions in Europe in the 1970s and the 1980s identified regularities in the phases or stages of urban development, with centralization, decentralization and decline being experienced sequentially according to the spatial cycle theory (Klaasen, Molle & Paelinck, 1981; Hall & Hay, 1980; van den Berg, et al., 1982). This research visualized functional regions as relatively self-contained, because the focus was on internal flows.

In particular, Cheshire (1995) has later criticized this simplistic approach. He emphasized that such sequences are more complex and not necessarily unilinear. Instead, he finds evidences of cumulative causation, related to human capital production and mobility of human capital. Functional regions "with advantages in attracting skilled residents can cumulatively improve living conditions and experience recentralization and growth, while functional regions with fewer advantages may experience continuing decentralisation and decline" (Cheshire, 1995, 1058). Thus, the focus is shifted from morphology and structures to flows of people, ideas, knowledge and capital – flows not only within functional regions but also between functional regions of different sizes and where the development of different functional regions is becoming more and more dependent upon their position with a network of transactions (Batten, 1995). Modern functional regions are unprecedentedly based on mobility, which has been experiencing accelerated growth in recent decades (Amin & Thrift, 2002). They are also situated at the nexus of diverse global flows, since mobility is globalizing (Montanari, 2002). This has been captured elegantly by Massey (1994, 154):

"All places are a hybrid mixture of local and more widely stretched relationships… the question is the ways in which the stretching, articulation, and intersection of different social relations across time-space have changed, and how this reorganization of social relationships in time-space is altering people's concrete experience of their world… need to understand places as made as articulated moments in networks of social relationships and understandings."

Thus, functional regions are constituted of both local and more distanciated relationships. This implies that researchers should take a broader relational approach to both the development of functional regions and globalization (Katz, 2001).

The obvious conclusion from this simple analysis applying a network approach is that it from a policy point of view is not enough with a place-based regional policy targeting individual functional economic regions with their specific development problems. The place-based policy must be complemented by a network policy with a focus on targeting the improvement of critical linkages in different transport and communications infrastructure systems. The structural-change process can be supported by policies that alleviate occupational and geographical mobility.

5 Functional economic regions versus administrative regions as units for spatial economic analyses and regional policy

In chapter 3, we described how economic activity is organised in functional economic regions. We described the economic development in functional regions in depth. In chapter 4 we collected a discussion about how functional regions form a system in which the functional regions are more or less connected. Our conclusion is that functional regions are critical for spatial economic analyses, since such analyses must be made at the spatial level at which the market subjects operate.

Only then can data analyses provide accurate and consistent results and allow useful interpretations of economic variables and indicators as well as the measurement of the true spill-over effects between spatial units. The functional regions are not overlapping but geographically contiguous. They completely cover a larger territory and thus ensure an unambiguous assignment of spatial units for researchers, planners and policy makers. The heterogeneity between the functional regions for particular measures related to the economy and the labour market is expected to be larger, the larger the coherence of the localities within the functional regions. Functional regions are the natural basic areas for regional policy making including public infrastructures and services, business development, innovation policies and human capital development and attraction (Oberst, 2012).

We argue for an increased use of functional economic regions as the spatial unit in economic studies and for regional policies. The often used NUTS-regions are often too large and heterogeneous to produce the correct results and be useful for policy. Let us use Sweden as a case in point. According to Statistics Sweden (2015) Sweden had 73 local labour markets 2013. This should be compare to the eight NUTS-2 regions (Eurostat, 2011). It is clear that the NUTS-2 regions are too large to be used in economic studies and for regional policy. Sweden is divided into 21 NUTS-3 regions. It is clear that also the NUTS-3 regions are too large to be used for spatial economic analyses and regional policy. The NUTS-3 regions do not (even closely) resemble the functional economic regions. In our opinion, an increased use of functional regions has the potential to more correct results and as a consequence relevant policies. That means that we overall could get a better economic situation in the regions of EU for the same amount of resources. Hence, one could argue that it is an efficiency gain to switch from NUTS regions to functional regions.

OECD (2002) published a survey of definitions and use of functional regions for many countries and suggested analysis of the territorial disparity between administrative regions and functional regions. In Sweden the administrative regions (NUTS-3) are very different from the local labour market. In other countries the administrative regions, e.g. NUTS-3 regions, and local labour markets may be more similar. In that case the use of the administrative regions would not be too bad. In other words, the consequences affects countries differently.

6 Conclusions and suggestions for future research

In this study, we have elaborated on spatial aspects of economic activity and development. We have extensively illustrated that most economic activities takes place in

functional economic regions. Current economic activity and development in functional regions are explained by resources, scale and history. A country consists of a system of functional regions, which are more or less specialised. Therefore it is clear that the economic development may be different in geographically close functional regions. For those reasons functional regions are the appropriate spatial unit for economic studies. Use of functional regions as the spatial unit in regressions would ensure that the necessary assumptions, in that way, are met. The use of larger spatial units would most likely violate the assumptions. With the use of functional regions the result of economic studies would be parameters of the correct sign and size. Use of other spatial units (e.g. administrative regions such as NUTS-regions) may lead to misleading results. In order for regional policies to target the right place and to be effective it is imperative that the parameters are correctly estimated.

We have argued for a use of functional economic regions as the spatial unit for economic studies. However, that does not only mean that the data should be per local labour market. Such a use of space in economic modelling is shallow. Using functional regions in that way only partially capture spatial aspects. It is far better to use spatial measures actively, not just as a dimension of data. Here we would like to mention accessibility, which is an underused tool for economic analyses (Gråsjö & Karlsson, 2015). The consideration of functional regions in accessibility calculations are very useful. It is for example of interest to a firm if the customers live close or far from the firm. This can be captured by calculation of the accessibility to customers (or purchasing power) within the home municipality (node), in other municipalities in the functional region and in other regions. Such a distinction is valuable, since it is highly likely that such accessibilities are of different importance to the firm.

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