CESIS

Electronic Working Paper Series

Paper No. 14

ICT, Functional Urban Regions and the New Economic Geography[1]

CHARLIE KARLSSON

(JIBS)

September 2004

The Royal Institute of technology
Centre of Excellence for studies in Science and Innovation
www.infra.kth.se/cesis/research/workpap.htm
Corresponding author: charlie.karlsson@jibs.hj.se

[1] Status of the paper: Submitted for publication in *Engineering Economics*

ICT, Functional Urban Regions and the New Economic Geography

Charlie Karlsson
Jönköping International Business School
Jönköping University
P.O. Box 1026
SE-551 11 Jönköping
Sweden
Phone: +46 36 15 69 53
Fax: + 46 36 12 18 32
E-Post: charlie.karlsson@jibs.hj.se

Introduction

The rapid developments in information and communication technologies (ICT) and the increased use of ICT motivate the vision of an evolving digital economy. ICT is composed of a wide range of product and service technologies including computer hardware, software and services and a host of telecommunications functions that include wire or wireline, wireless, satellite products and services. The advent and diffusion of this cluster of technologies has been considered a major force of productivity and economic growth (Antonelli, 1993). The rapid diffusion of ICT has produced important changes in how and where goods and services are produced, the nature of the goods and services produced, and the means and channels by which goods and services are brought to the market and distributed to customers. During the last decade this evolving digital economy has been the pre-eminent driver of structural change and economic growth at both the national and the regional level in the developed, industrialised economies.

The reason is, of course, that ICT functions as a new generic technology, which impacts society both broadly and deeply. ICT has, in essence, destabilised the near equilibrium conditions of an earlier time and contributed to conditions of greater disequilibrium. Thus one major implication of ICT is that it has created prime conditions for entrepreneurial discovery and action. This implies that there are strong motives to study various aspects of the digital economy, since ICT continues to penetrate the developed economies also after the burst of the ICT stimulated stock market bubble.

In this paper we will concentrate the analysis to one aspect of the digital economy, namely its effect of the system of functional urban regions. The motivation for this focus is that ICT offers new tools to organise information and enables major reductions in geographical transaction costs, the full implications of which is not yet well understood (Stough, Kulkarni & Paelinck, 2002; Johansson & Karlsson, 2001).

In the 1980s and early 1990s, some cyber prophets predicted that the emergence of the digital economy would kill distance and make urban regions superfluous (Toffler, 1980; Naisbitt, 1995; Negroponte, 1995; Knoke, 1996; Cairncross, 1997). The basic idea was that the spread of the use of ICT would strongly reduce or even eliminate agglomeration economies and hence make economic activities totally "foot-loose". At the beginning of the 21st century, however, it has become clear that this picture is at least single-sided. There is increasing evidence that the digital revolution reinforces the position of leading urban regions (Castells, 1989; Hall, 1998; Castells, 1996; Wheeler, Aoyama & War, 2000, eds.). Cities are a means of reducing the fixed travel costs involved in face-to-face interactions. Even if in principle improvements in information technology could eliminate the demand for face-to-face interactions and make cities obsolete, empirical results point in the direction that telecommunications is mainly a complement to face-to-face interactions (Gaspar & Glaeser, 1998).

At the same time we can observe how the use of ICT makes work at a distance a reality, ICT also makes it possible to locate information handling activities, such as call centres, in peripheral regions. At the same time we must observe that rural and remote communities tend to lag behind urban ones with regard to ICT infrastructure, services and human resources (Ramirez, 2001).

Furthermore, leading urban regions are concentrations of knowledge – human resources, universities and R&D institutes – and knowledge constitutes the principal "input" in the digital

economy. Leading urban regions are also leading centres of innovation but also host newly propulsive and emergent economic growth sectors such as tourism and cultural industries. Leading urban regions are growing in importance as places where information is created and interpreted. The shift towards growing reliance on tele-mediated information, electronic transactions, and financial flows, as well as the continuing importance of fashion, art, the media, dance, consumption, leisure, research, collective consumption, travel, tourism, education, and governance place a premium on reflexivity, interpretation and innovation – the key assets of large urban regions (Storper, 1996).

Hence, it is obvious that the emerging digital economy has a potential to reshape intra-regional as well as inter-regional activity patterns (Karlsson & Klaesson, 2002). However, even if considerable research has been conducted on the spatial implications of ICT it remains inherently difficult to assess the social and economic impact of ICT on regional and local development. Certainly, there is a substantial amount of evidence on the possible impact of ICT on "physical space" based on technical engineering characteristics of these technologies. But the acknowledgement and recognition of such characteristics represent of course nothing more than the listing of the various enabling technical factors. Addressing them does not imply any kind of technological determinism, but rather an emphasis that ICT from the perspective of possible spatial impacts represents a radical set of new technologies, despite the many, increasingly popular claims to the contrary. Contrary to other previous radical technological breakthroughs, ICT appears, in particular, to be characterised by its use flexibility. As a consequence, there is much more "malleability" in the impact of ICT on physical space. This malleability is in a sense extreme. It ranges from a relatively straightforward diffusion process of ICT (foremost as a set of complementary technologies reinforcing existing regional and local development trends including many forms of reorganisation of existing production and distribution activities), to much more radical, "creative destruction" diffusion process whereby ICT acts as substitution technologies challenging and in some cases even replacing existing regional trends. These developments provide a complex picture of the possible impacts of ICT on physical space that cannot be easily summarised.

It is obvious that in order to be able to analyse the diverse effects of ICT on the system of functional urban regions we need a strong theoretical framework that can help us sort out these diverse effects. The new economic geography field offers such a framework. In the sequel we will use such a framework to assess the effects of ICT on the system of functional regions.

The developments within ICT have resulted in

- A fast improvement in the quality of ICT equipment and software, and a concomitant sharp decline in their quality adjusted prices
- A dramatic decline in the price and a dramatic increase in the speed of information processing
- A dramatic decline in the price and a dramatic increase in the speed of information transfer
- A technological driven digital convergence between telecommunication and computer technology
- The establishment of an international electronic network – the Internet.

These developments within ICT have fundamental effects in various markets in the economy. They change the conditions in the labour market by making distance work a real opportunity.

They reduce transaction costs in both consumer and producer markets. Transaction costs is a process-oriented concept that in sequence is made up of search, negotiation, contract and enforcement costs. The search costs and probably also the negotiation costs will decrease with an increased use of ICT, i.e. e-commerce yields market co-ordination cost advantages (Garicano & Kaplan, 2000). E-commerce is, for example, more efficient than other forms of distribution when the goods/services involved can be digitalised and delivered online, as in the case of software, music and financial brokerage services. It may also be associated with lower distribution costs in the case of search goods, or of those goods or services, which do not require much information to the customer. However, it is not true in the case of experience goods, i.e. when information on the goods/services only can be obtained by direct inspection of consumption. Generally speaking, finding sellers and buyers is easier in the digital economy but the scope for price deviations will be narrower. However, the costs of policing and enforcing contracts might increase for many goods and services. In an impersonal market the trust necessary for trade with non-standard goods and services might be difficult to create (Gambetta, 1988; Williamson, 1993; Brynjolfson & Smith, 2000). The scope for different types of fraudulent behaviour is wider. However, overall we expect transaction costs to decline.

The spatial effects of the developments within ICT will among other things depend upon (i) the availability of an infrastructure for electronic connections, (ii) the level of service provided, i.e. the quantity and speed of information transmitted (band width), (iii) the level of ICT use, and (iv) the speed of development of new types of services provided by the electronic networks (cf. Wigan, 1987). ICT will mainly have three types of spatial effects: (i) effects on mobility of people and products, (ii) effects on location of households and firms, and (iii) effects on the productivity of firms due to differences in the spatial diffusion of ICT and thus in ICT usage. In the case of mobility effects the major question is of course, whether substitution or complementarity effects will dominate. It must in this case be remembered that ICT will have direct effects on the supply of transport as well as indirect effects on the demand for transport (Salomon, 1986).

Over time we, certainly, expect ICT to affect the location behaviour of households and firms. The direction of the effects is not totally clear. The industrial patterns of concentration and convergence will of course be influenced. Concentration is the tendency of an industry to cluster geographically, while convergence is the tendency of an industry to become more uniformly distributed geographically, i.e. less concentrated over time. One important implication of the spread of ICT is that it makes it possible to transfer routine information rapidly between different locations. This implies that ICT makes it easier to decompose production and locate each stage of the production process to the region that minimizes costs for a given quality level. This will speed up relocation of standardised stages of production to low-cost locations.

The effects of ICT on the system of functional urban regions have been analysed before but in most cases from an *ad hoc* perspective (see e.g. Bertuglia & Occelli, 1995) However, to fully appreciate the full effects of ICT we need a suitable model framework. In the sequel we present such a model framework and discuss what ICT-related effects on the system of functional urban regions that we should expect.

1. ICT in the New Economic Geography

The conceptions of economic development in modern regions have gone through a fundamental change since the beginning of the1980's. Today, regions are increasingly looked upon

as independent market places that are connected via interregional and international trade and not as administrative units embodied in a national unit. Two different but complementary theoretical frameworks explain the economic specialization of regions. The traditional but insufficient framework assumes that the comparative advantages of regions depend upon differences in the supply of lasting resources.

The new complementary framework known as the new economic geography assumes that the dynamic interaction between geographical market potentials and rational firms in its own way creates the comparative advantage of regions. These comparative advantages take the form of localised increasing returns to scale, e.g. the formation of highly competitive and rapidly growing industrial clusters. In this framework the role of regions as market places and as carriers of specialisation advantages is stressed. Economic development in a country is no longer a question about national specialisation and competitive power but about regional specialisation often based on clusters and geographical competitive advantages.

It is a fundamental observation that economic activities are clustered in space. This may be seen as a prerequisite for the existence of agglomerations. Industrial clustering can be described as place-specific increasing returns to scale, due to positive externalities generated by co-located activities (McCann, 2001). As such it is closely to the concept of agglomeration economies accruing inside urban regions that has been promoted not least by Krugman (1991), but which roots go back to Marshall (1920).

Cluster formation and agglomeration economies can be related to the concept of economic milieu (Klaesson & Pettersson, 2001). A cluster constitutes an economic milieu that provides advantages to the individual firms in the cluster by enhancing productivity and reducing cost levels. Cluster formation can be seen as the result of either a self-organised process or as a result of local policy initiatives (Cullen, 1998; Steiner, 2001).

2.1 A Stylised Model of the New Economic Geography

Current research on the links between regional market potentials and scale economies has produced a rich variety of models. However, most of these models have a common theme. Some common aspects for many models related to the new economic geography are illustrated below.

Increasing returns are a common theme in these models. In the simplest case externalities emerge as a consequence of market interactions involving economies of scale at the level of the individual firm. To deal with this situation it is common to use a spatial version of the Dixit-Stiglitz model of monopolistic competition that allows for multiple locations and transport costs between different locations (Dixit and Stiglitz, 1977).

These models, in their most elementary form, contain two sectors: agriculture and manufacturing. The agricultural sector is perfectly competitive and produces a single homogenous good. On the other hand it provides a large variety of differentiated goods, is characterised by increasing returns and hence imperfectly competitive. The number of potential manufactured goods is very large.

Production and consumption takes place at a specific location in a geographic space with discrete locations. All consumers have the same preferences and a taste for variety. Each variety of the manufactured good is produced in only one location. All varieties produced at a par-

ticular location are symmetric, having the same technology and price. Economies of scale arise for different levels of variety and no economies of scope are allowed.

Agricultural and manufactured goods can be shipped between locations and may incur shipment transport costs. Total sales of a specific variety depend on income in each location, the price index in each location, transport costs and the mill price. Because of increasing returns to scale, consumers' preferences for variety and the unlimited number of potential varieties of manufactured goods, no firm will choose to produce the same variety as another firm.

Hence, each variety is produced in only one location by a single specialised firm. This means that the number of firms is equal to the number of varieties. Here all scale effects work through changes in the variety of goods available. The number of firms in each location is related to the size of the manufacturing labour force in a location.

A location or region with a large manufacturing sector has a lower price index for manufactured goods, because a smaller proportion of this region's manufacturing consumption has to bear transport costs. The region with the larger home market has a more than proportionally larger manufacturing sector and therefore also exports manufactured goods. This phenomenon is known as the home market effect. Locations with large concentrations of manufacturing also tend to have a large demand for manufactured goods.

2.2 Increasing Returns and Internal Economies of Scale

The idea of increasing returns is a basic ingredient in modelling approaches related to the new economic geography. Without increasing returns it is virtually impossible to explain the geographical concentration of firms, regional specialisation and the importance of the home market. Increasing returns is also a basic explanation for trade among regions. If the relationship between the scale of production and the average cost per produced unit is negative, scale advantages exist, which are synonymous with increasing returns to scale.

The major explanation for the existence of increasing returns is that some production factor in a firm is fixed. Such a fixed production factor gives rise to a cost that is fixed and independent of whether production is small or large in a given interval. The most common explanations to the existence of fixed factors of production are indivisible resources and so called set up costs, which consist of development, start-up, establishment, preparation and training costs. These latter costs are normally associated with labour and immaterial resources, while indivisible resources are most often associated with capital objects such as buildings, facilities, machines and material networks. Other examples of fixed factors are knowledge assets, brand names and non-material networks.

A fixed production factor can be most closely compared to a catalyst, which must be present in production. As such it generates a cost – often a start up cost – but the use of the resource is not dependent upon the volume of production or if the firm has many or few customers. The steady decrease in the price of ICT hardware and software is a factor, which reduces the fixed costs of firms. Thus, in general the spread of ICT should tend to reduce the effect of internal economies of scale in many industries. This implies that ICT in general will support entrepreneurial activities in all industries in the private sector and this will apply for regions of all sizes.

2.3 Geographic Interaction Costs

To deepen the analysis it is necessary to acknowledge the existence of geographical interaction costs. In the stylised model transportation costs was introduced in a simple way. However, geographical interaction costs include not only transportation cost but also geographical transaction costs. Furthermore, to make the concept of a functional urban region meaningful we have also to acknowledge below that the geographical variation in interaction costs for many activities and products is non-linear (cf. Johansson and Karlsson, 2001).

The interaction in the market place between demand and supply naturally induces various forms of interaction costs, including transport costs. These costs include search costs, communication costs and other costs for exchanging information. When formulating a contract, the product (good or service) must be described, inspected, and assessed by the seller as well as weighed and measured whenever this is possible. The good to be transferred must also be examined and accepted by the buyer. Other causes of transaction costs are negotiations, consultation of legal advisers, discussions with financiers, and documentation of the agreement. Obviously, such costs are especially high when a product is not standardised. Such a product may be specially designed for a given customer or it may be in an early phase of its product life cycle when interaction with individual customers is particularly crucial for successful delivery. These contacts are usually distance sensitive, because they require face-to-face contacts. The normal method to reduce transaction costs is to standardise the product as well as the transaction procedure. Of course, standardisation is facilitated when demand becomes sufficiently large and the relevant technology harnessed.

In a world with constant returns to scale in all production activities neither high nor low geographical interaction costs can explain why regions grow more or are larger than other regions. If the geographical interaction costs are very high, it is of course most rational to split up and spread out the production and supply each regional market with local production via micro firms. If on the other hand the geographical interaction costs are very low then it does not impact whatsoever where production is located. But all this is true only if firms have constant returns to scale, i.e. when no internal economies of scale exist. Of course, there exists, in particular, some service industries delivering personal services that have almost no economies of scale. There are also industries that have relatively high geographical interaction cost due to the character of the services delivered. In these industries one finds a kind of micro firm that is located almost everywhere.

However, when internal economies of scale exist geographical interaction costs will influence the location of production. As ICT as a general tendency will reduce transaction costs, it will also reduce the geographic interaction costs. Reduced interaction costs in a world with internal economies of scale will induce an increased concentration of production.

2.4 Market Potentials and Increasing Returns

A region’s market potential is determined by its accessibility to customers and the purchasing power of these customers. If the market potential of a region is small in relation to the efficient scale of a firm with increasing returns, then that firm cannot choose such a location. In particular, this holds if the demand per customer is small or if the customers seldom demand the actual product. In such a case the demand curve is below the average cost curve over its entire stretch, i.e. there is simply no production scale such that the cost per unit produced is lower than the customers’ willingness to pay.

The full exploitation of increasing returns presupposes a market potential that is large enough, i.e. large market potentials become economically meaningful phenomena only when there are firms with internal economies of scale. A large regional market potential is attractive for firms with scale economies. Hence, such firms with internal economies of scale try to find regions that can offer larger market potentials. This observation represents a basic dynamic mechanism that generates regional growth and concentration in a self-reinforcing way. Having pronounced economies of scale, firms will locate in regions that have large market potentials and thus some large regional markets evolve because firms with economies of scale locate there. In this way, a cumulative relationship is established that is driven by the interaction between internal economies of scale, demand growth and geographical interaction costs. As ICT tends to reduce the geographical interaction costs it will tend to increase the speed of these cumulative relationships.

Internal economies of scale at the firm level in this way become a kind of external effect that is mediated by the market. In larger urban regions these internal economies of scale become a kind of collective agglomeration advantage, which means that the urban milieu as a whole can be characterised by scale economies. It is only in a world with internal economies of scale that geographical interaction costs (in an interplay with the market forces) can give rise to cumulative processes and agglomeration advantages (Krugman, 1993). Furthermore, with internal economies to scale and cumulative processes it is possible to show that regions that basically have the same production resources may specialise in quite different ways.

With this view of the world, regional specialisation is to some extent a historical accident. The locus of a particular industry – with the exception of industries dependent upon natural resources – is to a large degree indeterminate, and history-dependent. But once a pattern of specialisation is established for whatever reasons such a pattern gets "looked in" by the cumulative gains from interregional trade. There is a strong tendency towards "path dependence" in the patterns of specialisation and trade between regions. In short, history matters.

As long as cumulative effects generate an increasing market potential in a region, a market place for an increasing number of industries and firms with internal economies of scale is created. For firms that are located in such a market place the regional market can be considered as their home market. If such firms get customers outside the home region, export to other regions is generated.

2.5 Increasing Returns and Large Urban Regions

Without internal scale economies in most firms and/or external economies of scale, geographical concentrations, and, in particular, large urban regions, become basically incomprehensible economic milieus. Large urban regions should simply not exist. Firms in large urban regions should not be able to cover those extra costs that arise due to the fact that costs for land and premises often are many times higher in large cities than in sparsely populated regions. Another but related insight is that the more knowledge dependent manufacturing and service industries increase the prevalence of internal scale economies. With such a development the manifold of demand for specialised goods and services increases and the frequency of scale economies increases.

A concept that is related to internal economies of scale is economies of scope. Such economies exist in their simplest form when the total costs for producing two different products

within one firm is lower than the sum of the total costs of producing the two products in two different firms. Economies of scope are basically the result of several products using the same fixed resource within in the firm. Hence, economies of scope are a basic motive for product differentiation within firms. Product differentiation often gives rise to large internal economies of scale and in practically all firms there are examples of economies of scope. In this connection the most important insight about economies of scope is that they, in the same way as ordinary internal economies of scale, give rise to cumulative market effects. This means that firms with economies of scope will try to locate in regions with a large market potential and that the market potential of these regions grows because such firms locate there.

If the theories about cumulative relationships with internal scale economies, geographical interaction costs and regional market potentials are taken seriously, they imply that larger regions are the home market for firms in many more niches and industries than small regions. Krugman (1992) shows theoretically, for example, that the number of products produced in a regional market is proportional to the size of its labour market. But this only holds if there exist internal economies of scale. By reducing the geographical interaction costs ICT will generally increase the reach of large regions and thus enhance their possibilities to take advantage of their scale economies.

2.6 Functional Urban Regions

A functional urban region is in a fundamental way characterised by its density of economic activities, social opportunities and interaction options (Ciccone and Hall, 1996). From the perspective of the individual firm, density is a positive factor to the extent that it creates accessibility to households, firms and other actors. The density may also relate to a specific industry. Such intra-industry density is an important phenomenon also in small and medium-sized functional regions. Industry-wide density exists mainly in metropolitan or other large regions with a large home market for local products.

Economic density can be interpreted as intra-regional accessibility, where “region” is defined as a functional urban region. However, in the discussion here it is not density *per se* but accessibility to resources and economic agents that matters. Density is a positive factor to the extent that it creates accessibility to households, firms and other economic actors. Accessibility is obtained by an appropriate combination of density and infrastructure and it is the dynamic interaction between these three factors that forms the core of regional development. If density increases and the infrastructure remains unchanged, congestion and other tensions may follow. As a consequence, accessibility is reduced and the value of density declines. Infrastructure without matching density, on the other hand, represents only idle opportunities. The concept of infrastructure here relates to both transport and communications infrastructure. Thus, ICT will contribute to increased accessibility and stimulate regional development at given levels of congestion.

Economic density can be interpreted as intra-regional accessibility within a functional urban region, i.e. accessibility to resources and between economic actors. Central place systems and filtering-down models recognise density of purchasing power in a general sense. A dense region has an advantage in the production of goods and services with contact intensive sales. Location advantage and spatial product cycle models, on the other hand, focus on the density of firms producing similar or related products and of input suppliers and labour categories, which are specialised with regard to the cluster.

A particular geographical market will, according to the conceptualisation presented here, become equal to a functional urban region when the localised firms and households have very small geographical interaction costs. What factors will then delimit such a functional urban region? Basically it has to do with which primary resource that has the largest geographical interaction costs and that thereby establishes a geographical border for factor mobility. Disregarding fixed resources such as land and natural resources the major limiting factor is normally the labour force and its propensity to commute. As ICT generates possibilities to distance work we can expect the geographical borders of functional urban regions to be extended and the number of functional urban regions to decline. This implies that ICT will stimulate urban sprawl. People that only have to commute, for example, three days a week can be expected to commute longer distances per day.

The geographical interaction costs between different market places for work are for households, in principle, equal to the total costs for moving between market places, i.e. between different labour markets. According to this conceptualisation, functional urban regions become equal to local labour markets. In the short and medium term it is only within such markets that the vast majority of the labour force is mobile between work places, firms and industries.

2.7 Home Market Effects

Given the existence of cumulative relationships between economies of scale, geographical interaction costs and regional market potentials, there exist economic advantages and incentives to concentrate production in the region with the largest home market, even if there exists a demand in other regions. This phenomenon is known as the home market effect and implies that regions will export those products for which they have the largest home market in relative terms (Krugman, 1990; Davies and Weinstein, 1997). To understand the significance of home market effects we study trade with goods and services between regional market places, i.e. functional urban regions. The different functional urban regions are separated by the geographical interaction costs and it is only these costs that meaningfully distinguish different functional urban regions. Within each functional urban region the interaction costs are assumed to be relatively small and in practice negligible.

Consider now the system of functional urban regions and we find that some functional urban regions are specialised due to the location of specific natural resources. Disregarding such location factors it is possible to identify two major types of endogenous specialisation. The first is a combination of home market size and internal economies of scale. The second is localisation economies, i.e. industry-specific external economies of scale.

Situations or regions with strong non-linear geographical interaction cost curves create a home market advantage for suppliers of contact-dependent products motivating the region to view these products as local products. If the number of potential buyers within the home market region is large and if their purchasing power is high then this creates a strong home market potential. Economic activities with strong internal economies of scale will enjoy a particular advantage from locating in a region with a large home market as defined here.

If internal economies of scale exist, the cumulative relationships imply that a functional urban region will export those products to other functional urban regions, which it has largest home markets for. Hence, home market effects should primarily be considered as effects of the size of the labour markets in different functional urban regions. This adds a new dimension to our

discussion. A principal conclusion of the discussion to this point is, that the variation in the number of industries in a functional urban region mainly is explained by the size of the labour markets, respectively. It is differences in size of local labour markets that determines the extent to which a functional urban region is characterised by versatility in the composition of its private sector and to what extent a functional urban region becomes a home market with exports to other functional urban regions.

The home market for products with high distance sensitivity (costs) ends at the border of the functional urban region. Such products are often called local commodities or even "non-tradeables". However, the design of product attributes as well as transaction procedures may, as a consequence of new technical solutions in combination with increased transaction volumes, change and lower the curve for geographical interaction costs. Infrastructure investments that lower the friction in the transportation and communication systems and/or bridge geographical barriers may have similar effects on these curves. It seems obvious that ICT by offering, for example, possibilities for e-commerce will that more local commodities will become "tradeables" and thus increase the number of goods and services that are traded between regions.

The curve for the geographical interaction costs for products with low distance sensitivity may, of course, have a steeply increasingly section on the curve further away, e.g. when the delivery passes a language and/or a cultural barrier. However, within such borders the home market is extended and there exist no significant home market effects for large urban regions, i.e. products with a small or no distance sensitivity normally have a much larger home market than products with high distance sensitivity. Products with very low distance sensitivity may even be labelled global products. With the advent of ICT and the Internet more goods and services become global.

Products with low geographical interaction costs can be located in a much less restricted way than products with high costs. In this case the location advantages will, in particular, depend upon the accessibility in the inter-regional transport networks. As ICT and the Internet will lower the geographical interaction costs for many goods and services, the number of goods and services that become foot-lose will increase with the implication that more goods and services will have locational freedom.

Consider now a firm, which sells much of its output in distant export markets, i.e. whose products have low distance sensitivity. However, this firm may have input supplier accessibility requirements. This latter type of accessibility concerns specialised labour inputs as regards skill and knowledge, specialised services including R&D-services as well as current material inputs. Suppose now that these input suppliers have internal economies of scale. In that case these suppliers will have an incentive to locate in the same functional urban region as the exporting firm, if the demand in the region for their deliveries is large enough. If the exporting firm is not large enough, sufficient demand may be created if several firms of the same type locate in the same region. This would then represent a specialised demand density, which is big enough to match the internal scale economies of the input suppliers. The overall conclusion is that even firms with products with low distance sensitivity may be attracted to the larger urban regions by the large variation of inputs supplied by these regions.

2.8 Demand Dynamics and Home Market Effects

To this point in the discussion the focus has been targeted at the importance of the size of the home market for taking advantage of internal economies of scale. Of course, it is not only the size of the market that determines the possibilities of taking advantage of internal economies of scale and, hence, the variation of firms and industries in functional urban regions. Besides the size of the market it is in particular, the composition of demand and its rate of growth that stimulates cumulative geographical processes. This has been stressed by, for example, Sölvell, Zander and Porter (1991, 30): "While home demand through its influence on economies of scale can confer static advantages, its more important influence is on the character and the rate of innovation by a nation's firms. Three broad characteristics of home demand are significant: the composition of home demand (or nature of buyer needs), the patterns of growth of home demand and the ability of domestic needs to be transmitted internationally."

For functional urban regions to create and maintain growth and renewal they must have customers – households and firms – that create a demand for the products of the future. As long as the demand per customer is very small there is a need for dense geographical markets with many customers so that they together can create a demand that gives enough scale advantages to one or several entrepreneurs. This is one of the most important explanations for large regions having external advantages for new products.

Often it is not enough with many customers. Customers, which are sophisticated, knowledgeable, and demanding, are particular assets in many large functional urban regions, since they can express early and future-directed demand. The nearness to such demand can in larger, functional urban regions very rapidly give rise to competitive advantages through internal scale economies and lead to home market effects. Such effects can be turned into real competitive advantages when firms that exploit early demand impulses in a regional market are able to move the products competitively to other regional and national markets.

Specialisation in an individual functional region does not primarily come from a large general demand. It builds upon idiosyncratic demand, in particular when products are young. With a dynamic perspective it also becomes critical that old and obsolete products are rapidly liquidated and that the firms in a functional urban region have the ability to find new possibilities using impulses, innovations, techniques, ideas, and so on, from other functional regions. Here the Internet offers new options to get impulses from other regions.

2.9 Home Market Effects and Export Specialisation

A large demand density is synonymous with a functional urban region having a large home market for many own products (and for many imported products!). Such regional markets become an attractive location for both small and large firms with internal economies of scale. On the other hand, if a functional urban region has a thin structure and a small home market, then its economic growth must be based upon demand coming from other functional urban regions. In such a case the production in the region must be concentrated on products for which the geographical interaction costs rise very slowly when selling and deliveries take place over long distances. When the home market in a functional urban region is small the supply of products that demand a large home market will also be limited. Hence, functional urban regions whose firms are concentrating on products for which the geographical interaction costs increase very slowly with distance, will often be dependent upon firms that do not or rather can not demand goods and services from other firms located in the same region. The home market is simply not large enough for these kinds of products. Clearly this implies a strong limitation for the future development of these regions. This explains why regions with

small home markets as a rule are characterised by a small number of export industries, often characterised by large internal economies of scale.

For functional urban regions with large home markets, on the other hand, home market effects often arise within many niches and industries, which implies that firms with such a home market as their base often also supply other functional urban regions. Under such circumstances firms can first build up their competitive power in their home market and then at a later stage widen their home market to nearby regions. But the critical decision comes when the firms decide to build up their competitive power inter-regionally and internationally. Early home market effects and the accompanying regional specialisation will then be turned into global competitive advantages. From this it follows that large regions as a rule have more international export industries than smaller regions.

2.10 Specialisation and Co-location

Internal economies of scale are not the only explanation why firms concentrate spatially and, hence, that certain functional urban regions become large. External economies of scale also play an important role. This phenomenon has to do with a qualitative change in a region's economic milieu that takes place when several firms with related activities (in the same industry) are located close to each other. In this case it is the external scale of an industry in a functional urban region in terms of the number of co-located firms that matters.

When there exist external economies of scale the unit costs for each firm in an industry in a functional urban region will decrease as the number of firms in the industry in the region increases. With decreasing costs co-located firms can increase their productivity and their factor rewards, i.e. wages and profits. The advantages coming from co-location is one of the reasons why there exist both small and large functional urban regions. In small functional urban regions firms get decreasing costs and increased productivity through co-location of one or a small number of industries, i.e. through specialised co-location (location economies).

In larger functional urban regions normally many firms within many different industries are co-located and together they form a complex and integrated milieu of co-located firms. The external economies generated by such economic milieus are known as urbanisation economies.

Firms that are dependent upon internal and external economies of scale will locate in functional urban regions, where there exist co-location advantages and when more firms locate in such a region the co-location advantage increases. Thus, we have a cumulative process, where internal and external economies of scale interact in a self-reinforcing way.

The analysis of external economies of scale was initiated by Marshall (1920). He showed how a regional economic milieu is created in a more or less self-organised way and in a manner that supports and expands a specialisation that has already begun. In principle there exist three primary explanations for the emergence of external economies of scale, i.e. three forces of agglomeration, in a functional urban region:

- The location of specialised supporting firms supplying non-traded, i.e. distance-sensitive, local inputs.
- The emergence of specialised labour markets securing a local skilled-labour supply.
- Intra-regional spill-overs of information and knowledge.

Each of these three phenomena can develop and strengthen a specialisation and growth process in a functional urban region that has been initiated by internal economies of scale. Because of high geographic interaction costs the distance-sensitive inputs are substantially more expensive when delivered from sources outside the region. Thus, proximity becomes an advantage when supplier and customer firms are co-located in the same region. To the extent that ICT reduces geographic interaction costs this force of agglomeration might be reduced. The second category relates to the labour acquisition costs of firms. In a region where many persons in the labour force have the demanded skills, the costs of a firm to expand its labour force will be lower than if people must be retrained or recruited from other regions. This force of agglomeration is probably not reduced by ICT. On the contrary the option to work at a distance might rather strengthen this force.

According to the above arguments, the higher the proximity to specialised input suppliers and a labour supply with the right specialisation implies the lower the total prices to acquire inputs for given quality levels. Thus, these two types of agglomeration economies have the character of pecuniary externalities. Information spillovers, on the other hand, have a non-pecuniary character and are instead technological externalities. This means that in agglomerations information is available locally as a public good, and brings benefits without any price being charged, except (possibly) in the form of higher land prices. Hence, to take full advantage of the external economies of scale in a functional urban region there is a need for meeting places outside the market place.

2.11 Interactions in the System of Functional Urban Regions

While large functional urban regions can develop based upon diversification small and medium-sized urban regions must develop based upon a specialisation on products with geographical interaction costs. Development in small and medium-sized regions are based either upon the location of a limited number of large scale production units with substantial internal economies of scale or upon the co-location of many smaller production units in a few well delimited industries. Small and medium-sized regions, which are not specialised in industries based on natural resources, often have advantages in the production of standardised components and services for systems products that are assembled in larger regions. Small and medium-sized urban regions normally exhibit high location quotients for a limited number of industries.

Traditional economic theory has often shown that the agglomeration of people and firms in large urban regions will lead to a concentration with negative effects such as overcrowding, noise, environmental disturbances and dirtying. However, the new economic geography shows that agglomerations also generate positive external effects for firms as well as households.

The interaction between market size and economies of scale induces agglomeration and urbanisation advantages in large functional urban regions, which functions as centripetal (concentrating) forces. High and increasing land and labour costs in large, growing functional regions and high interregional interaction costs functions as centrifugal (de-concentrating) forces. As ICT decreases the interregional interaction costs they may well weaken the centrifugal forces in the digital economy.

We have already noticed that the large functional urban regions are the nexus for the development, introduction and early production of new products. However, over time most products tend to become more and more standardised with

- A decreased contact intensity
- Decreasing distance sensitivity
- More uniform design and technology
- Lower production costs.

In a parallel process the new products get growing customer groups, which over time have got acquainted with the new products and which have started to afford to demand them. When products in this manner become standardised the demand in more and more regions becomes large enough so that firms that starts production there of new products can get enough income to cover both their fixed and their variable costs. This development implies that geographic concentration of production often will be broken as products mature and that the actual industries will be spread out in wider and wider patterns and to regions with lower and lower market potential.

In regional economics two alternative processes as regards the diffusion of products and industries from large to medium-sized and small functional urban regions are distinguished: the filtering-down theory and the spatial product life cycle. In summary the filtering-down theory states that new products and new industries successively are established at lower levels in the size hierarchy of functional urban regions. The speed of this process is determined by the speeds by which the fixed set up costs decline and the regional demand increases. The demand increase can be a result of increasing real incomes, of changes in taste and preferences and of lower prices due to the standardisation of products and production processes. According to the filtering-down theory the spatial diffusion of new products and industries will follow a hierarchical pattern:

- Most rapidly to other large functional urban regions
- At a slower pace to medium-sized functional urban regions
- Slow and often only partly to small functional urban regions.

The spatial product life cycle theory states that new products and industries will be established outside the large functional urban regions where they were initiated when products and production processes have become standardised due to

- Increased competition for and thus increased prices for the fixed or semi-fixed production factors in the large functional urban regions
- Decreased dependence of the external effects, i.e. the urbanisation economies, that the large functional urban regions offer
- Decreased start up costs (in some cases)

Product life cycle diffusion is often connected with the introduction of large-scale production, and given that the standardisation process also has led to a decrease of geographical interaction costs new production will normally be set up in a very limited number of medium-sized and small functional regions. Often regions with a good position in the logistical networks will be preferred.

It is of course a central question whether the digital revolution at the margin will stimulate concentration or de-concentration in the system of functional regions. De-concentration would of course imply a decline in spatial variation, and in the long run the end of cities. The question of concentration or de-concentration has been analysed within the so-called new growth theory (Lucas, 1990; Romer 1990). According to this theory the new digital economy leads to cumulative-and-circular divergence of economies. The functional urban regions that have an initial advantage in ICT will enjoy a variety of internal and external benefits that will allow them to develop their advantages further. This position has been supported by a body of empirical evidence, largely stemming from the new approaches of Barro and Sala-i-Martin (1992), showing that regions are not converging significantly in their economic performance and certainly not in a way consistent with neo-classical analysis (Nijkamp & Stough, 2000). Kolko (2002) found that information technology intensive industries exhibit slower convergence than other industries. This is certainly an interesting result in particular since so many regions look upon such industries as the major sources of future jobs. The results also indicate that clusters of information technology intensive industries persist not because they are technology-intensive per se, but because they tend to rely on high-skilled labour. Furthermore, a new-firm birth analysis suggests that information technology reduces the need for firms to locate near their clients, which may slow the convergence of service industries. Since convergence reduces the long-run efficacy of place-based economic policies, public policies that attract low-skill support functions for information technology intensive industries confer only short-term benefits in exchange of potentially large upfront costs (Kolko, 2002).

If ICT in the long run should lead to the end of cities is closely related to the degree to which ICT is a substitute for face-to-face contact (Gaspar & Glaeser, 1998). Urbanisation broadly follows a consistent hierarchical pattern (Krugman, 1996). Whether this pattern is sustainable in the context of the widespread use of ICT and the Internet could of course be questioned. However, it is difficult to see how a widespread use of ICT and the Internet should reduce the agglomeration and urbanisation economies offered by large functional urban regions to such an extent that the hierarchical pattern would break down (cf. Moss & Townsend, 1998; Zook, 2000). ICT and the Internet is both centralising and de-centralising (Peitchinis, 1992).

2.12 ICT and Regional Policy in the New Economic Geography

The growing penetration and popular adoption of ICT has given rise to wide and diverse expectations and policies geared to affect economic and social systems, not least in terms of their spatial configuration. A clear example is the popular belief in the net substitution for travel, which at present cannot be supported by hard data (Salomon, 1998). However, to fully understand the options for regional policies in the digital economy we must have a general understanding of the scope of regional policies in the new economic geography.

According to the modern theory for endogenous regional growth the growth of regions spring from internal conditions that can be influenced. With such a view will regional development policy deal with conditions that mainly must be developed and implemented with local and regional knowledge as a base even if a holistic view and financial support can come from "above". The list of political means, which can be used to stimulate economic growth at the regional level, is large and differentiated.

One overall problem in regional policy in all types of regions is to deal with processes that operate at different time scales. Product markets as a rule change rapidly and this demands that lasting capacities – human capital, real capital, infrastructure capital, and so on – be

adapted. The problem is that such capacity adaptation processes are much slower processes and in particular processes connected with much more inertia than processes in the product markets. If the delay in the development of labour supply, built environment and infrastructure is large, the growth process can be retarded and rapidly turn into another phase. The opportunities to fight delays in capacity adaptations and to create sustainable growth are to be found in a long-term credible regional development policy that is able to reduce the market's uncertainty about the region's growth conditions.

One important conclusion from the literature on the new economic geography is that regional policies must be designed differently for regions of different size.

Large regions base their economic growth on a continuous introduction of new products and an early imitation of new products introduced in other large regions. Thus, the development of large regions is strongly dependent upon their innovation potential. The innovation potential is on the one hand a function of a large intra-regional market potential built up by demanding customers with a high willingness to pay for new advanced products. Customers that often are taking active part in the product development. The innovation potential are on the other hand made up by rich and dense import networks, a large supply of R&D resources and a highly educated labour force. This implies that regional policies in large regions should focus in particular interregional accessibility, R&D capacity and the capacity of institutions of higher education.

However, a strong innovation potential is not enough to secure economic growth in large regions. For new products and industries to develop and in particular to grow there must also exist mechanisms that secure that resources gradually are pressed out of maturing industries and made available for the new growth industries. This means in practice that growth in large regions is strongly related to the functioning of the relevant markets. Without well-functioning markets for labour, land, premises and housing large regions may never reach their full growth potential and resources might instead be kept to long in old industries. Hence, it is an important objective for regional policies in large regions to create and to preserve well functioning markets for resources strategic for economic growth.

The success of smaller regions is closely connected with the emergence and conservation of competitive clusters or to use another concept development blocks (Dahmén, 1988). Increased internationalisation driven by among other things an increased economic integration implies that it is important for smaller regions to support the conditions that are offered to important clusters in the region as well as to potential new clusters. Assuming perfect information the new economic geography framework motivates a cluster specific regional policy. However, there are numerous problems associated with a cluster specific regional policy that have to do with risks for manipulation, lobbying and the existence of assymetric information.

Due to the existence of positive external effects the existing clusters in a region will not achieve an optimal scale spontaneously. This situation opens a number of questions. How to determine the optimal scale of a cluster? How can existing clusters be stimulated to achieve an optimal scale? How to set priorities among different existing clusters when the resources for regional policy are limited?

In those cases where one or several existing clusters tend to loose competitive power and it is impossible from a long-term perspective to balance these losses with specific cluster policies questions are naturally raised concerning new potential clusters. How to identify new poten-

tial clusters? How to make priorities between potential new clusters? How to get new clusters established? How to make sure that new clusters reach a large enough scale to function as a cluster and to assure that they over time reach an optimal scale?

Internal economies of scale are mainly outside the regional policy domain. However, policies that lead to reduced fixed costs for labour and capital reduces the firm's dependence of the size of the regional market. In particular, rents and real estate values that vary geographically play an important role for generating geographically varying costs for firms.

Geographical interaction costs are among other things determined by national and regional transport and communication policies. Lower geographical interaction costs widen the borders of functional regions and hence provide space for the development and growth of more industries and firms with internal economies of scale. The profitability of investments in infrastructure capital is higher in an economy with cluster mechanisms than in an economy without.

As industrial clusters consist of firms that best are able to profit from a region's market potential and its supply of lasting resources, regional development policy should primarily focus the possibilities to support, develop and expand existing clusters. To the extent that existing clusters are unable to carry a region's development there is a question about the possibilities of identifying and developing new expansive clusters. If a decision is made to try to establish new clusters it is important to identify their need for lasting infrastructure capacities. To support established as well as new industrial clusters it is important for regions to create optimal conditions for entrepreneurship, location of new firms and firm growth. Hence, regional policy should never focus on individual industries or firms except when they form strategic parts of an existing or a new cluster.

Large shares of the knowledge development in a region are characterised by collective characteristics. New knowledge that, for example, is developed in one firm will over time diffuse to other firms, other regions and other parts of the economy. Through such a process increasing returns is created in the economy as a whole. This means that the growth in a cluster and a region can be influenced by investments in knowledge and R&D.

2. Concluding Comments

It has been the intention of this paper to add to the complex picture of the possible impacts of ICT with a special focus on spatial impacts and at the same time hopefully, in some instances, making the picture less complex. The concluding part of the paper highlights three important aspects of the emerging digital economy, which needs to be focused more in future research:

- Innovation and entrepreneurship
- Location and dynamics of ICT industries
- Telecommunications and policy

3.1 Innovation and Entrepreneurship

Innovation through the creation, diffusion and use of knowledge has become a central driver of economic growth. However, the determinants of innovation performance have changed in the globalising knowledge economy, partly as a result of recent developments in ICT. Innovations result from increasingly complex interactions among individuals, enterprises and different kinds of knowledge institutions. However, important elements of the process of inno-

vation tend to be regional, rather than national or international. These trends are probably most important in science-based and high-technology industries such as ICT industries. This means that innovation activities are localised and that they tend to cluster in regions offering favourable conditions for innovation. Thus, regional innovation networks are emerging and creating new forms of learning and knowledge production (Florida, 1995). One important aspect of these localised clusters of knowledge production is that investment in R&D and other sources of new knowledge spills over and can be exploited by third-party economic agents, i.e. entrepreneurs. Hence, the relevant focus is economic agents confronted with new knowledge or new combinations of old knowledge and their decisions of whether and how to act upon that knowledge (Audretsch, 1995). This issue is at the heart of modern entrepreneurship research (Shane & Venkataraman, 2000).

3.2 Location and Dynamics of ICT Industries

Many observers show that the development, production, and application of ICT infrastructure, hardware and software occur first and foremost in or near urbanised economic core regions (Alles, et al., 1994; Graham & Marvin, 1996; Schmand, et al., 1990; Shields, et al., 1993; Quah, 2001). Many urban regions in the US and Europe host a large ICT sector that has grown rapidly during the 1990s (van Winden, 1990). However, the location of industries normally changes over time. Thus, it is relevant to ask how does the digital economy in general, and ICT industries, in particular, develop in space nationally across the system of functional regions and internationally? An important purpose of the theory of spatial industrial dynamics is to explain why the economic milieu of a functional urban region can be advantageous for certain sets of economic activities and less advantageous for others, and why economic activities diffuse and/or relocate between functional regions. What are the conditions for diffusion/relocation to occur? What are the driving forces behind diffusion/relocation? What are the mechanisms of diffusion/relocation? What industries are diffusing/relocating? What geographical patterns do the diffusion/relocation processes follow? What does the interaction pattern between functional regions of different size look like?

3.3 Telecommunications and Policy

The emergence of the digital economy is intimately connected with the emergence of new telecommunications networks and infrastructures where the traditional copper and coaxial cable links are increasingly being supplemented or replaced by optic fibre, wireless, microwave and highly efficient satellite systems. This strong connection has generated expectations that investing in telecommunications infrastructures has a positive effect on economic growth and levels of development. However, the casual relationship between telecommunications investments and economic growth is not clear. Telecommunications investments could bring about economic growth, or economic growth could bring about increased investments in telecommunications but most probably the relationship is reciprocal over a period of time (Gillespie & Cornford, 1996). Whatever the casual relationship it seems obvious that variations in the capacity and the quality of telecommunications infrastructures is exerting a growing influence on corporate decision making about the location of activities. Thus, the spatial patterns of investments in telecommunications infrastructure are likely to influence the patterns of spatial centralisation and decentralisation in the economy. Traditionally the telecommunications sector has been strongly regulated in most countries. Even if the sector in recent years has been deregulated in many countries a significant amount of regulation still prevails. The strategic role played by telecommunications infrastructure for the emergence of the digital

economy and the still significant role played by political decision making makes telecommunications and policy a very important research area for national economic development.

References

Alles, P., A. Esparza & S. Lucas (1994), Telecommunications and the Large City – Small City Divide: Evidence from Indiana Cities, *Professional Geographer 46*, 307-316

Antonelli, C. (1993), *The Diffusion of Technological Systems and Productivity Growth: The Case of Information and Communication Technologies*, Dresden; Herausforderung für die Informaitonstechnik Internationale Konferenz

Audretsch, D. (1995), *Innovation and Industry Evolution*, Cambridge, MA, The MIT Press

Barro, R.J. & X. Sala-i-Martin (1992), Convergence, *Journal of Political Economy 100*, 223-251

Bertuglia, C.S. & S. Occelli (1995), Transportation, Communications and Patterns of Location, in Bertuglia, C.S., M.M. Fischer & G. Preto (1995), *Technological Change, Economic Development and Space*, Springer-Verlag, Berlin, 92-117

Brynjolfson, E. & M. Smith, Bundling and Competition on the Internet, *Marketing Science*,

Cairncross, F. (1997), *The Death of Distance*, Harvard Business School Press, Boston MA

Castells, M. (1989), *The Informational City. Information Technology, Economic Restructuring and the Urban-Regional Process*, Oxford; Basil Blackwell

Castells, M. (1996), *The Rise of the Network Society. The Information Age: Economy, Society and Culture*, Volume 1, Oxford; Blackwell

Ciccone, A. and R.E. Hall (1996), Productivity and the Density of Economic Activity, *The American Economic Review 86*, 54-70

Cullen, J. (1998), Promoting Competitiveness for Small Business Clusters through Collaborative Learning: Policy Consequences from a European Perspective, in Steiner, M. (1998) (Ed.), *Clusters and Regional Specialisation*, London; Pion

Dahmén, E. (1988), 'Development Blocks' in Industrial Economics, *Scandinavian Economic History Review XXXVI*, 3-14

Davis, D. and D. Weinstein (1997), Economic Geography and Regional Production Structure: An Empirical Investigation, Harvard University and NBER

Dixit, A.K., and J.E. Stiglitz (1977), Monopolistic Competition and Optimum Product Diversity, *American Economic Review 67*, 297-308

Florida, R. (1995), "Toward the Learning Region", *Futures 27*, 527-536

Gambetta, D. (1988), *Trust: Making and Breaking Cooperative Relations*, Blackwell

Garicano, L. & S.N. Kaplan (2000), The Effects of Business-to-business E-commerce on Transaction Costs, NBER Working Paper 8017

Gaspar, J. & E.L.Glaeser (1998), Information Technology and the Future of Cities, *Journal of Urban Economics 43*, 136-156

Gillespie, A. & J. Cornford (1996), Telecommunication Infrastructures and Regional Development, in Dutton, W.H. (1996) (Ed.), *Information and Communication Technologies. Visions and Realities*, Oxford; Oxford University Press, 335-351

Graham, S. & S. Marvin (1996), *Telecommunications and the City: Electronic Spaces, Urban Places*, New York; Routhledge

Hall, P. (1998), *Cities in Civilization. Culture, Innovation and Urban Order*, London; Weinfield and Nicholson

Johansson, B., & C. Karlsson (2001), Geographical Transaction Costs and Specialisation Opportunities of Small and Medium-Sized Regions: Scale Economies and Market Extension, in Johansson, B., C. Karlsson & R.R. Stough (2001) (Eds.), *Theories of Endogenous Regional Growth. Lessons for Regional Policies*, Berlin; Springer-Verlag, 150-180

Karlsson, C. & J. Klaesson (2002), The Spatial Industrial Dynamics of the ICT Sector in Sweden, in Acs, Z.J., H.L.F. de Groot & P. Nijkamp (2002) (Eds.), *The Emergence of the Knowledge Economy. A Regional Perspective*, Berlin; Springer-Verlag, 243-275

Klaesson, J. & L. Pettersson (2001), Regional Economic Milieu – the Importance of Variety of Service Provision, in Pettersson, L. (2001), *Location, Housing and Premises in a Dynamic Perspective*, JIBS Dissertation Series No 010, Jönköping, Jönköping International Business School

Knoke, K. (1996), *Bold New World: The Essential Road Map to the Twenty-First Century*, New York; Kodansha

Kolko, J. (2002), Silicon Mountains, Silicon Molehills: Geographic Concentration and Convergence of Internet Industries in the US, *Information Economics and Policy 14*, 211-232

Krugman, P. (1990), *Rethinking International Trade*, Cambridge, Mass.; The MIT Press

Krugman, P. (1991), *Geography and Trade*, Cambridge, MA; The MIT Press

Krugman, P. (1992), *A Dynamic Spatial Model*, Cambridge, Mass.; National Bureau of Economic Research, NBER Working Paper, 4219

Krugman, P. (1993), First Nature, Second Nature, and Metropolitan Location, *Journal of Regional Science 33*, 129-144

Krugman, P. (1996), *The Self-Organising Economy*, Oxford; Blackwell

Lucas, R.E. (1990), Why Doesn't Capital Flow from the Rich to Poor Countries?, *American Economic Review 80*, 92-96

Marshall, A. (1920), *Principles of Economics*, London; Macmillan

McCann, P. (2001), *Urban and Regional Economics*, Oxford; Oxford University Press

Moss, M.L. & A.M. Townsend (1998), Spatial Analysis of the Internet in US Cities and States, Paper given at Urban Future – Technological Futures Conference at Newcastle upon Tyne, England, 23-25 April, 1998

Naisbitt, R. (1995), *The Global Paradox*, New York; Avon Books

Negroponte, N. (1995), *Being Digital*, New York; Vintage Books

Nijkamp, P. & R.R. Stough (2000), Growth and Change", *A Journal of Urban and Regional Policy 31*, 451-454

Peitchinis, S.G. (1992), Computer Technology and the Location of Economic Activity, *Futures 24*, 813-820

Quah, D. (2001), ICT Clusters in Development: Theory and Evidence, *EIB-Papers 6*, 85-100

Ramirez, R. (2001), A Model for Rural and Remote Information and Communication Technologies: A Canadian Exploration, *Telecommunications Policy 25*, 315-330

Romer, P.M. (1990), Endogenous Technical Change, *Journal of Political Economy 98*, S71-S102

Salomon, I. (1986), Telecommunications and Travel Relationships: A Review, *Transportation Research A 20*, 223-238

Salomon, I. (1998), Technological Change and Social Forecasting: The Case of Telecommuting as a Travel Substitute, *Transportation Research Part C 6*, 17-45

Schmand, J., F.H. Williams & R. Wilson (1990), *The New Urban Infrastructure: Cities and Telecommuncations*, New York; Preager Publishers

Shane, S. & A. Venkataraman (2000), The Promise of Entrepreneurship as a Field of Research, *Academy of Management Review 25*, 217-226

Shields, P., et al. (1993), Who Needs POTS-Plus Services? A Comparison of Residential User Needs Along the Rural-Urban Continuum, *Telecommunications Policy 17*, 563-587

Steiner, M. (2001), Clustering and Economic Change: New Policy Orientation – The Case of Styria, in Johansson, B., C. Karlsson & R.R. Stough (2001) (Eds.), *Theories of Endogenous Regional Growth. Lessons for Regional Policies*, Berlin; Springer-Verlag, 278-298

Storper, M. (1996), The World of the City: Local Relations in the Global Economy, School of Public Policy and Social Research, University of California, Los Angeles

Stough, R., R. Kulkarni & J. Paelinck (2002), ICT and Knowledge Challenges for Entrepreneurs in Regional Economic Development, in Acs, Z.J., H.L.F. de Groot & P. Nijkamp (2002) (Eds.), *The Emergence of the Knowledge Economy. A Regional Perspective*, Berlin; Springer-Verlag, 195-214

Sölvell, Ö., I. Zander and M.E. Porter (1991), *Advantage Sweden*, Stockholm; Norstedts

Toffler, A. (1980), *The Third Wave*, New York; Bamtam Books

Van Winden, W. (2000), Three ICT Clusters Compared, Paper presented at the 40th Congress of the European Science Association, Barcelona

Wheeler, J.O., Y. Aoyama & B. Warf (2000), *Cities in the Telecommunications Age. The Fracturing of Geography*, New York; Routhledge

Wigan, M.R. (1987), Change in the Relationships between Transport, Communications and Urban Form, *Transportation 4*, 395-418

Williamson, O.E. (1993), Calculativeness, Trust, and Economic Organisation, *Journal of Law and Economics 36*,

Zook, M.A. (2000), The Web of Consumption: The Spatial Organisation of the Internet Industry in the United States, *Environment and Planning A 32*, 411-426