

**ICT clusters in European cities during the 1990s:
development patterns and policy Lessons**

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Abstract

This paper is based on an EU-funded research project called “MUTEIS” (Macroeconomic and Urban Trends in Europe’s Information Society) – a research project designed to get a better understanding of the different patterns of growth of urban regions and their ICT clusters across Europe. Over the 1990’s Europe as a whole seems to have been slow in its transition towards the new, digital economy. The smaller European economies of Finland, Ireland, Sweden and The Netherlands, however, witnessed a rapid uptake in ICT investments and in computer- and internet use over the second half of the 1990’s, accompanied by a remarkable growth and employment performance over those same years. This paper reveals how those countries have been better equipped to exploit some of the new digital growth opportunities, adapted existing “old” economic activities to the new e-business environment, and learnt more from the new opportunities to exploit those advantages across the European Union. Furthermore, the national policy makers appeared to be more aware of the increasingly limited degrees of freedom of their national policy actions, liberalising more rapidly their national telecommunications monopolies.

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1. INTRODUCTION

At the Lisbon European Council meeting of 23-24 March 2000, the European Union put itself a new strategic goal: “to become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion”. The Lisbon summit noted in particular Europe’s lagging compared to the United States in investments in ICT hardware and software and ICT services more generally. This continuous lagging over the 1990’s in such knowledge investments coincided with Europe’s lagging growth and productivity performance compared to the US. As a matter of fact, for the first time in post-war history, the growth pattern of the US, Europe and Japan diverged: effectively a pattern of forging ahead of the United States.

The comparison between the US and Europe hides a very differentiated picture within the EU. Some of the smaller European economies (such as Ireland, Finland, Sweden, and The Netherlands) actually witnessed a rapid uptake in ICT investments and in computer- and Internet use over the second half of the 1990’s, accompanied by a remarkable growth and employment performance over those same years. These smaller countries – some with an important ICT-niche producing sector, but most with little actual manufacturing involvement in ICT – have been better equipped to exploit some of the new digital growth opportunities, adapted existing “old” economic activities to the new e-business environment, and learnt more from the new opportunities to exploit those advantages across the European Union. Furthermore, the policy makers in those countries appeared more aware of the increasingly limited degrees of freedom of their national policy actions, liberalising more rapidly their national telecommunications monopolies.

A similar story could be told inside each of these countries with respect to regional and urban developments. Behind the aggregate stories of success, sometimes initiated by the private sector, sometimes by public authorities, we can see significant differences in the regional and urban development patterns in the field of ICT- and Internet use. These differences provide essential ingredients so as to understand better the macro-economic overall pattern. They provide invaluable insights for other local initiatives in the area of ICT use and diffusion in other European countries.

The aim of this study is to give a descriptive and analytical assessment of ICT cluster development in Europe and to derive policy lessons for cities. On the basis of recent developments in the ICT sector, existing literature on industrial agglomeration, regional development and the development of the local knowledge economy, we have constructed a framework of analysis and a methodology. This framework has been applied to before mentioned smaller economies in Europe: Finland, Ireland, Sweden and The Netherlands. (We refer to those countries as the FINS countries). In each of these countries we have analysed two types of urban regions: a core urban region and a peripheral city. As core regions we selected the national capitals: Helsinki, Dublin, Amsterdam and Stockholm. These urban areas are the national front-runners in the transition to the digital economy and host a relatively large and rapidly growing ICT sector. The second type of urban regions are located in a peripheral location, but have nevertheless found an "urban niche" in the information society. We selected Oulu (Finland), Jönköping (Sweden), Groningen (Netherlands) and Cork (Ireland).

2. ICT CLUSTERS: A CONCEPTUAL FRAMEWORK

In the course of the 20th century, many economists and geographers have developed theories to describe and explain location in space. One of the best known is Marshall (1920). He observes that economic activity is often clustered in the same locations, and derives the conclusion that there must be *agglomeration economies*: the higher costs of location in concentrations must be compensated somehow.

The first source of agglomeration economies is the existence of information spillovers: a relatively easy exchange of knowledge, information and ideas between firms. In particular the exchange of tacit information is relevant in this respect. This is information which is incomplete, and relates to issues such as new products, personnel, technology and market trends. The information is being shared through formal and informal networks on a non-market basis. (McCann, 2001). Tacit and informal knowledge spillovers require vicinity and face-to-face contact. This is why innovative and knowledge intensive activities are often spatially concentrated and clustered. The second source of agglomeration economies is the existence of non-

traded inputs. If a sufficient number of firms in the same industry are grouped together, there is a market for highly specialised services. Each of the companies benefits from the presence of these specialists. The third source of agglomeration economies is the existence of a local skilled labour pool. In a region where a large share of the labour force already has specialised skills, the costs for the firm to expand its labour force may be lower than in other regions.

Hoover (1948) makes a distinction between localisation economies and urbanisation economies for agglomerations. In our study on ICT clusters we have analysed both dimensions. *Urbanisation economies* are economies which accrue to firms across different sectors. (Jacobs, 1960, in McCann, 2002, p.58). Firms may benefit from the proximity of sales markets, infrastructure, commercial services and so on. *Localisation economies* arise from the co-location of companies in a particular industry. Such a concentration entails a local specialised pool of labour. Furthermore, it opens a market for specialised suppliers, dedicated research and educational institutes.

In this study, we compare the development of ICT clusters in several European cities. We have developed a frame of analysis that draws from the theoretical notions outlined above. In our view, the development of the ICT cluster depends upon access to the *benefits* of general and cluster specific conditions a certain location, and the actual *costs* of that location. (See figure 1.)

Access to general conditions

First, companies need *access to generic qualified labour*. Any firm, when making a location decision, will take this into account. The presence of qualified professionals largely depends on the level of wages and the quality of life the city. Florida(2002) notes that they are the new productive force driving the economic fortune of cities. These workers prefer inspiring cities with a thriving cultural life, and international orientation and high levels of diversity. Larger metropolitan areas are much more likely to attract this types of workers than remoter, smaller places.

Second, ICT companies will need to sell their products and therefore need *access to markets*. The degree to which a location offers access to markets depends on the size and character of the local economy, but also on the ease with which other markets can be served (van den Berg and Van Winden, 2002). A large part of the ICT sector can be considered as an “ordinary” business service sector. The larger the city, the bigger the local market for ICT products (Graham and Marvin, 1996). But also the composition of the local economy matters: if a city has an overrepresentation of sectors that are relatively ICT intensive (such as financial services), their ICT cluster is likely to be relatively larger. The degree of access to external markets is to a large extent determined by the ease with which other markets can be reached. The quality of transport connections is crucial here.

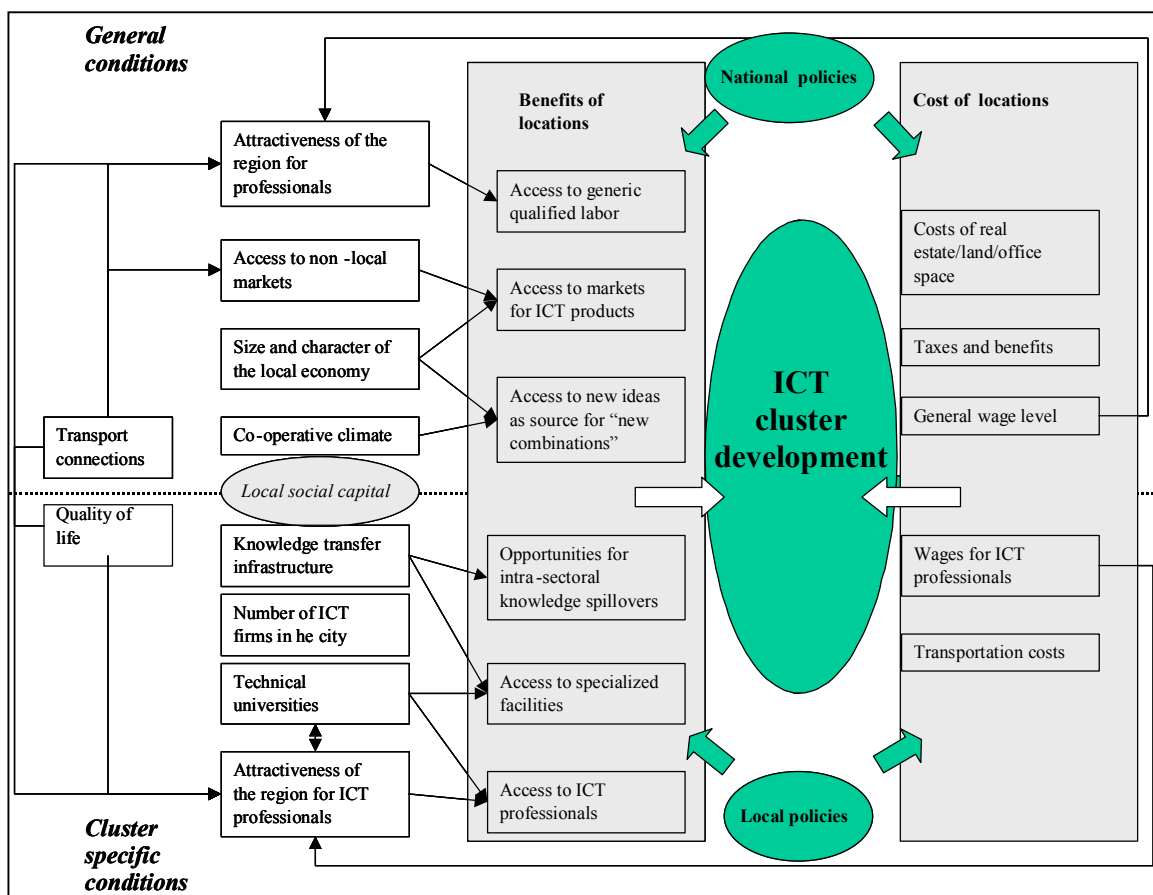


Figure 1: Determinants of ICT cluster development

The third factor is the degree of *access to new ideas* that may lead to innovations and new combinations. Urban diversity is generally considered to improve the access to new ideas. The importance of urban diversity as an attractor of innovative industry sectors – of which ICT is one – is demonstrated by Henderson, Kuncoro and Turner

(1995). This is in line with the earlier observation of Jacobs (1960). The combination of ICT expertise and other competences leads to a hose of new or renewed products, because information and communication technologies become increasingly embedded in other sectors and products. ICT companies may prefer locations in which they can develop these new combinations and exchange ideas with non-ICT companies. Also, the local co-operative climate influences this. Cities differ considerably in this respect.

Access to cluster specific conditions

The fourth factor closely resembles the third one, but is more cluster specific. When already many ICT companies are located in one place, *knowledge spillovers* are more likely to occur. This means that an individual company has better access to new, tacit knowledge on markets or technology, which may improve its competitive position. The occurrence of knowledge spillovers depends on the local co-operative climate (which is largely culturally determined), but also on formal institutions and structures that facilitate knowledge exchange.

Fifth, ICT companies may need *access to specialised services or facilities*. This can be research laboratories, test labs, or, for instance, law firms specializing in Internet law. The more firms locate in one place, the bigger the market for such specialized services and facilities. Also, universities can play an important role here.

Sixth, ICT companies need *access to highly skilled and specialised staff*. The availability of staff depends on the number of ICT firms already there (which entails a pool of specialized labour), and is also positively influenced by the presence of a (technical) university.

Costs of location

The development of an ICT cluster depends not only on what a region has to offer, in terms of access to location factors, but also on the costs. These costs can be divided into factor costs (wages, land, offices rents etc.) and transportation costs. Also, the level of taxes and benefits play a role.

In general, if a place is popular as a location, many firms will invest in that place. This will drive up the prices of land and real estate. Also, the living costs of the employees will rise, and firms have to pay higher wages to maintain the local labour supply. At some point, costs will be so high that localization and urbanization economies no longer compensate, and the growth of the cluster will stop.

Another effect of rising costs can be that the nature of the cluster changes. Rising land costs may drive space-intensive activities out of the city towards cheaper locations. Rising wages may have the effect that the city is only attractive for companies that enjoy very high localization economies and/or agglomeration economies. Rising costs of living may lead to some negative effects on the quality of life, as it may imply labour shortages in some sectors. Expensive cities are not attractive for people with salaries that are fixed on a national level, such as nurses, policemen or teachers: in real terms, they can earn more in cheaper cities.

Weights of location factors

Each individual company puts different weights to the six location factors. We may find big differences in location preferences for several types of ICT activity. For some ICT activities, such as R&D, access to markets is relatively unimportant. For sales and headquarter functions, the availability of generic staff is probably much more important than the presence of a technical university, or dedicated R&D facilities. Space-intensive and capital intensive firms will likely prefer lower-cost locations, whereas creative “high touch” sectors that are information-intensive (like the content industry) will prefer inner city locations.

Role of policy in building an ICT cluster

The localisation of clusters in space is largely a market driven process: companies locate somewhere to benefit from local resources or access to markets; cumulative processes may be set in motion through localisation and urbanisation economies, leading to cluster growth. However, governments have an important role, too. They can direct their efforts on both sides of our framework, addressing each of the subsequent determinants in the framework. On the one hand, governments may try to

lower the costs of a location, by providing incentives, tax breaks or subsidies. By doing that, they may lure companies to the region. Also, cities may improve the location factors they offer.

Each of these policies can be developed and implemented at the local, regional or national level. For each of our case studies, we will analyse the role of policy in the making of the cluster.

3. ICT CLUSTERS IN THE FINS: FACTS AND FIGURES

The ICT sector in the FINS (Finland, Ireland, The Netherlands and Sweden) is an important economic sector (OECD, 2001). The relative “export power” of ICT products ranges from 19% in Sweden to 35% in Ireland. These shares of total trade are substantially higher than the EU average, and competitive with the US.

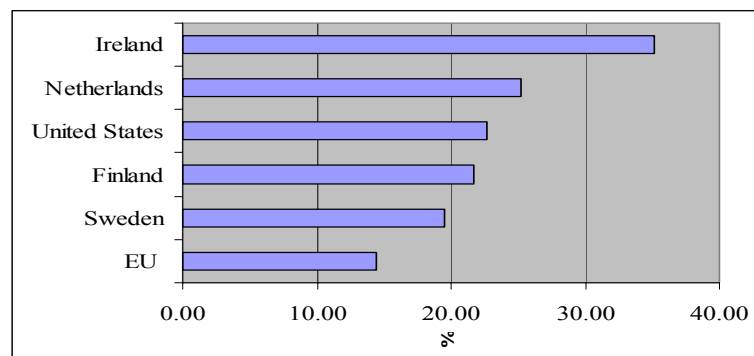


Figure 2: ICT manufacturing trade¹ by country as share of total goods trade, 1999; *OECD (2001)*.

OECD statistics from Finland, The Netherlands and Sweden indicate that the share of the ICT sector in total business employment is higher than in the US (5.8%). In Finland, the ICT sector has the highest relative weight, with over 9% of total employment.

The ICT sector generates more value added per worker than the average economic sector. According to figure 3, the share of the ICT sector varies between 8% (Netherlands) and 14% (Ireland).

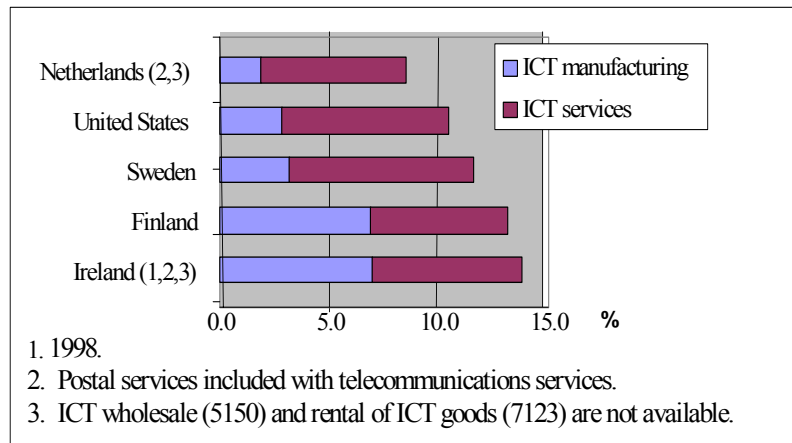


Figure 3: Share of ICT value added in business sector value added, 1999; *OECD (2001)*

Size of ICT sector in the cities²

Most cities in our case studies have an overrepresentation of the ICT sector employment compared to their national average. (See table 1.) As a general trend the overrepresentation in the number of firms is much less pronounced, which indicates that large companies dominate the ICT sectors of Helsinki, Oulu and Groningen. In Amsterdam, however, the reverse is true: 13.5% of establishments are ICT firms, while ICT's share in urban employment is only 10.5%. This indicates a large number of smaller firms in Amsterdam. There are remarkable differences in ICT sector employment among peripheral cities such as Oulu (15%), Groningen (6%) and Jönköping (5.5%).

	Share of ICT in total employment (%)		Share of ICT in number of establishments (%)	
	Region	Country	Region	Country
Helsinki	10.0	5.5	7.9	5.0
Oulu	15.0	5.5	4.9	5.0
Amsterdam	10.5	4.5	13.5	4.2
Groningen	6.0	4.5	4.1	4.2
Stockholm	-	6.3	9.1	5.5
Jönköping	5.5	6.3	3.4	5.5

Table 1: Share of ICT in total employment and establishments, 2000.

Table 2 represents the share of each urban region in the national ICT sector. The ICT sectors of Finland and Sweden are clearly concentrated in their respective capitals. Amsterdam's share in the Dutch context is far less impressive.

	Region's share in ICT employment (%)	Region's share in ICT establishments (%)
Helsinki	36	45
Oulu	6	3
Amsterdam	12	22
Groningen	2	1
Stockholm	43	42
Jönköping	1	1

Table 2: Share of urban region in national ICT employment and establishments, 2000.

Composition of the ICT sector

The ICT sector can be subdivided in several ways. In our study, as far as data were available, we discern sub sectors for hardware, software, telecom and content production and services. (See figure 4.)

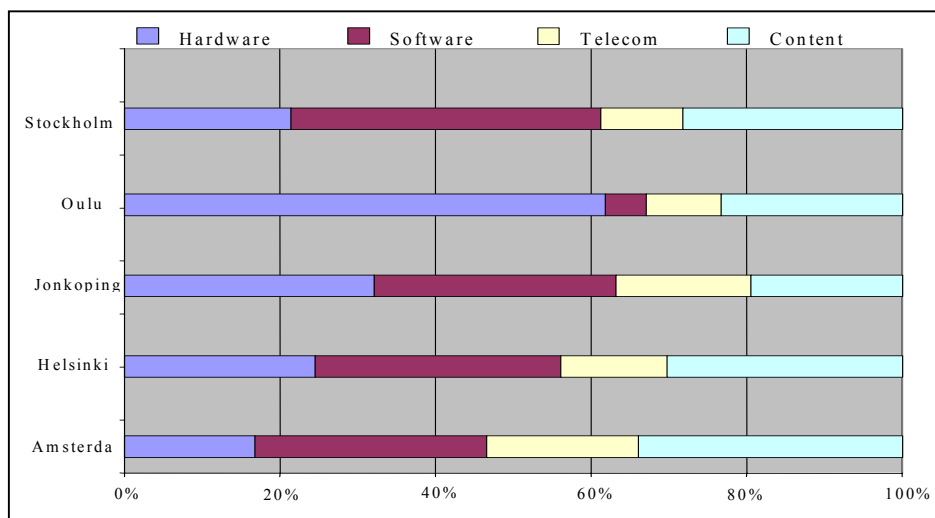


Figure 4: Employment in the ICT sub sectors, 2000

The hardware sector is mainly comprised of ICT equipment manufacturing. This sector is the strongest in Oulu and Jönköping. The software sector comprises software developers and vendors, and ICT consultancy firms. In most cities, software is the major sub sector. The share of the telecom sector is around 10% for most cities. The content sector includes relevant activities in publishing, advertising, motion picture and television. It is strongly developed in the larger cities, especially Amsterdam. Manufacturing activity may prefer remoter locations, as they are more space intensive and cost-sensitive.

Growth patterns

Most of the cities in our study experienced a growth of employment and an increase in the number of ICT establishments above the respective national average. In business terms, they increased their market share. Most of the growth took place in the second half of the 1990s. From 1995 to 1999, the average annual growth rate for ICT employment has been 8.3% in The Netherlands and 8.2% in Finland. These numbers were well above Sweden (3.2%) and the US (6.5%). Remarkably, the highest average growth has been in the smallest peripheral cities: Groningen and Oulu. On the other hand, the dominance of the larger cities has not substantially increased, at least in terms of employment and establishments.

The software sector has been the fastest growing sector in all the cities. (See figure 5.) In fact, it explains much of the growth of the entire ICT sector. In most cities, employment in this knowledge intensive sector increased annually by 10 percent or more, with the Finnish cities as leaders. It is remarkable that the telecom sector has not grown fast. In the Swedish cases it even declined. The hardware sector is not a strong grower either, except for Finland.

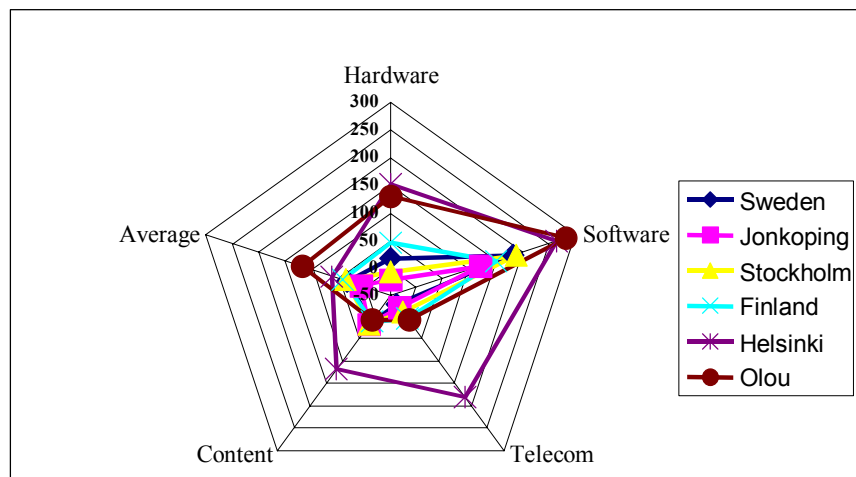


Figure 5: Total ICT employment growth of the sub-sectors, 1990-2000

4. QUALITATIVE ANALYSIS

In this section we take a closer look at some factors that influence the local development of an ICT cluster.

Skilled labour

In our case studies we found that the large cities have a large pool of specialized ICT skills. This is one of the key reasons for companies to locate there, and this, in turn, works as a magnet for ICT experts, thus igniting a virtuous circle. Our cases also show that the number of ICT experts in a city cannot be equalled with the number of people that work for ICT companies. Many ICT experts do not work in the ICT sector itself but in other parts of the service sector. In *Amsterdam* for instance, the largest employer of ICT staff is not an ICT company but the headquarters of a bank.

The image of a place plays an important role in attracting ICT professionals. *Oulu*, for instance, developed a strong image as “technology city” during the 1990s, with high capabilities in certain niche markets. Despite its peripheral location, the city managed to attract foreign investment and experts. In the case of *Amsterdam* and *Dublin* their hip and young international image helped to attract foreign investment and employees to the city. *Helsinki* and *Stockholm* have developed images of solid technology hotspots with a high quality of life.

Demand for the cluster's output

Our current study finds that the urban ICT sector, to a large extent, is a business service sector. A substantial part of the ICT sector services the local markets; they need to be where the clients are. Only for R&D activities and “confection” software, proximity to sales markets is less important.

In general, the international services cities *Amsterdam*, *Helsinki* and *Stockholm* have a strong and demanding local market for ICT services. This large market makes the city attractive for developers of new ICT products and services, as they have better chances of commercial success. The smaller cities don't have such a strong home

market. The ICT sectors in *Groningen* and *Jönköping* are predominantly locally oriented. Most of the larger companies here are regional branches. International activities are scarce.

This is not the case for *Cork* and *Oulu*. Their small home markets have not hampered ICT cluster development. Cork produces and tailors software for the world market. To some extent, the special characteristics of software distribution allow firms to disregard local market conditions. Oulu has managed to develop an international ICT cluster specialised in R&D. The R&D facilities in the city have many interfaces with the global knowledge economy.

Multinationals and foreign direct investment

In the “global network economy”, one of the issues is the relation between local and global knowledge and information. (van den Berg , Braun and Van Winden, 2001). With the general increasing pace of innovation, companies need linkages to sources of knowledge that are relevant for them. *Multinational companies* can be the link between the local and the global. Internationally oriented universities, or smaller local firms that are active on international markets can play the same role.

According to Ernst & Young (2001) the capital regions of Helsinki, Amsterdam, Stockholm and Dublin are all strong in international headquarter and sales functions, which reflects their strengths as advanced international service economies. Nevertheless, there are differences in the profiles of the cities. *Amsterdam* is attractive for ICT multinationals as basis to serve European markets and attracts relatively many sales & marketing activities. *Stockholm* and *Helsinki* have a much stronger R&D profile. Many foreign ICT companies have substantial R&D activity in these cities. However, Stockholm and Helsinki also have the headquarters of their own “home grown” multinationals; Ericsson and Nokia. Both have witnessed explosive growth during the 1990s, and contributed substantially to the growth of the ICT clusters. They have generated a lot of spin off for the local economies, as they participate in education programmes and intermediary organisations, support start-up initiatives, and maintain strategic co-operation with universities and firms in the cluster.

The growth of ICT clusters in *Dublin* and *Cork* was ignited by foreign companies. First, *Dublin* and *Cork* have managed to attract enormous amounts of foreign direct investment, especially from the US. The main reasons are that Ireland has the lowest corporate tax rates in the EU, and that the population is native English-speaking. Second, former employees of multinationals tend to start-up a company of their own. Multinationals exist largely apart from those small indigenous firms. ted

Transport connections

The regions of *Stockholm*, *Amsterdam* and *Helsinki* are excellently connected internationally, with major airports. Their internationally oriented ICT companies are thus well connected to international markets and resources. *Dublin* Airport is a bridge to the most important markets of North America. This is attractive to US-based multinationals, but it also puts markets on the east coast of America within reasonable reach of indigenous Dublin companies.

At the other side of the spectrum, *Oulu* seems to have a peripheral location in the European as well as in the national perspective. Yet external accessibility is seen as good, because of an easy accessible airport. Nonetheless, several Oulu based firms have established subsidiaries around the world in order to decrease the pressure for travelling and to improve the firms' service abilities.

5. LOCAL NETWORKS IN ICT CLUSTERS

In this section we discuss the prevalence and intensity of local networks that improve the access to ideas, or generate innovations.

Local inter-firm networks

Inter-firm relations may occur in different forms, such as:

- Customer-supplier relations (e.g. Business-to-Business and project based co-operation)

- Strategic co-operation (e.g. product development, common marketing)
- Informal relationships (e.g. networking organisations).

There are big differences in the degree of inter firm relations in the regions we investigated in the cluster studies. In *Amsterdam* most co-operation between companies falls within the category of customer-supplier relationships. The average small size of the firms demands extensive co-operation between firms. The highly interactive business climate in the Amsterdam region makes such co-operation possible and easy. Strategic co-operation of the larger ICT companies in the region mostly takes place on a national and global level, instead of the regional level. There is a rather low level of strategic local inter-firm networks. Global and local links also co-exist in *Oulu*, *Helsinki* en *Stockholm*.

The city of *Groningen* mainly exhibits links between companies in the region, while the cities of *Dublin* and *Cork* primarily have linkages with companies abroad. Table 3 summarises the findings.

	Local firms	Foreign firms	Overall judgment
Jönköping	-	-	-
Oulu	+	+	+
Groningen	0	0	0
Cork	-	+	0
Helsinki	+	+	+
Stockholm	0 / +	0 / +	0 / +
Amsterdam	0	-	- / 0
Dublin	-	+	0

Table 3 Strategic inter-firm relationships

Another important observation concerns the different attitude of SMEs and multinationals towards co-operation with other companies: SMEs tend to look upon other companies in the regional ICT sector mostly as competitors, while multinationals consider other ICT companies in the region mostly as possible partners for strategic co-operation.

Local linkages between firms and knowledge institutes

In *Amsterdam*, *Groningen* and *Jönköping* the number of linkages between the ICT business sector and the educational & research institutes is rather small. Examples of such co-operation were found in science park initiatives only. *Helsinki*, *Oulu* and *Stockholm* exhibit many linkages between ICT businesses and educational & research institutes. Many companies have joint projects or competence centres with local universities, for instance in R&D.

The formal and informal linkages between educational institutions and ICT businesses in *Cork* are quite strong. The knowledge institutes are an important part of the support structure for software firms in the region. Often, national development agencies and local government are involved.

Table 4 ranks the cities according to the prevalence of linkages between the knowledge infrastructure and the firms.

	Overall judgment
Amsterdam	- / 0
Cork	0 / +
Dublin	0
Groningen	-
Helsinki	+
Jönköping	0
Oulu	+
Stockholm	+

Table 4 Local linkages between firms and knowledge institutes,

Our case studies suggest that in the Scandinavian countries, partnerships between the knowledge institutes and the business are better developed than in the other countries. In the R&D intensive clusters (*Helsinki*, *Stockholm* and *Oulu*), there is more university-firm interaction than in the other clusters.

Another finding is that large companies have a higher propensity to co-operate with knowledge institutes than small ones. The main reason for this is that large companies have a bigger budget to spend on R&D. Finally, most of the companies in our case

studies find the presence of education & research institutes important, because this results in a larger ICT labour pool.

Intermediaries linking ICT players

Strategic links between actors in the ICT sector don't always come naturally. That's why many cities and regions have intermediary organisations that promote networking between companies, knowledge institutions and governments. All the cities in our study have intermediary organizations. In most intermediaries governments are involved. This reflects the widespread adoption of the view that governments can help to promote regional knowledge exchange. Intermediary structures have become a cornerstone of innovation policy. An additional benefit for government is that policymakers stay in closer touch with the ICT sector, which can help governments in taking sound decisions about economic policy.

6. ICT CLUSTER POLICIES

Our case studies suggest that national policies have had a great influence on ICT cluster development. Relevant national policy areas are: market regulation, taxation, innovation, education and regional development.

Market regulation policies have influenced the development of ICT clusters in Finland and Sweden. They were among the first countries in Europe to liberalise the telecom market. Liberalisation and an active role of the state in developing mobile communications paved the way for Nokia's and Eriksson's success and for the ICT clusters in Helsinki and Stockholm.

In Ireland *tax policy* was one of the drivers for the cluster's take-off, both in Cork and Dublin. The country offered the lowest corporate taxes in Europe, which attracted massive inflows of foreign direct investment (FDI). Also The Netherlands has relatively low corporate tax rates, which at least partly explains Amsterdam's success in attracting FDI. Finland and Sweden have relatively high corporate and income

taxes. This, however, has not prevented some of the “Nordic” clusters from growing strongly during the 1990s.

Innovation policies are the strongest in Finland and Sweden, followed by The Netherlands and Ireland. In Finland, many support structures are set up to enhance innovative activity. This National Technology Agency *TeKes* is a prime example. The central idea is to give companies and research institutes incentives to co-operate, and to promote new entrepreneurship. Another example is *Sitra*, the National Fund for Research and Development, which focuses on enterprises that are at the start-up stage. Finally, Finland supports six technology-transfer companies in university cities in Finland. These form a close-knit circle cooperating in the task of commercialising research results.

Regional development policies have been very important for the take-off of Oulu’s ICT cluster. In the 1970s, the Finnish government decided to invest substantially in the university of Oulu, to promote regional development in the north of the country. Also, tax breaks were offered to companies to encourage location in the north. For this reason, in 1972, Nokia started to produce radio equipment in Oulu for the Finnish military forces. Since then, Nokia has stayed and extended its activities. In the 1990s, it became one of the drivers of the ICT cluster.

In The Netherlands, the ICT cluster of *Groningen* has benefited from regional development policy, in two respects. Investment subsidies were provided for companies that set up businesses in the north of the country. Moreover, in the 1980s the government moved the headquarters of the national telecom company from The Hague to Groningen. It gave a positive impulse to the ICT cluster. In the 1990s however, the privatised telecom company moved its headquarters back to The Hague.

Local and regional policies

Our cases differ substantially in their ICT policies. One remarkable finding is that the four cities with the largest ICT clusters – Stockholm, Amsterdam, Dublin and Helsinki – hardly have an explicit policy to promote the ICT cluster. The smaller cities pursue a much more explicit and active policy.

The city of *Helsinki* regards all businesses equally important and has chosen to let the market guide the development. It confines itself to traditional methods of promoting the economy: city planning, transportation, housing, infrastructure, education etc. The interviewed companies saw the Helsinki strategy as a good one, but some wished the public sector would act as a more demanding and innovative customer.

Since the beginning of the 1980s *Oulu* City Council had a clear vision and strategy for information technology. An essential step was the foundation of the Technopolis Science Park in 1982. It was a joint project of the city of Oulu, the university of Oulu and local businesses. The city of Oulu began to appear frequently in the media as it started to invest in new technologies. This positive publicity still fosters the image of the technology city of Oulu.

In the early 1990s the region around the city had become more important as a working and living area. As a result the policy focus is now not only on the city of Oulu but on the larger Oulu region.

The city and county councils in the *Dublin* area have generally adopted the strategies of the Irish economic agencies. Ireland's highly centralised government structure means that policy at the local level broadly reflects national imperatives. Dublin City Council however also promotes local networking, and participates in cluster-specific projects. The new "Digital Hub" is an example.

The local authorities in the Dublin area tend to see each other as competitors. While the City Council pursues the kind of high density that is most attractive to small firms, the suburban county councils persist in creating business parks suitable for call centres, data warehouses and multinational corporations.

In *Cork*, like in Dublin, the authorities mainly carry out national policies. However, at the regional level, the South West Development Agency strongly supports companies with export potential in ICT. All private and public partners seem to recognise a shared fate in the success of the ICT cluster and the region as a whole. However,

although multinationals have an overall positive impact on the industry, they are less inclined to cooperate strategically than the indigenous local firms.

In *Amsterdam*, the municipality has an implicit ICT policy that leaves much initiative in the hands of companies. The city initiated and supports a number of informal networks of ICT and new media firms with knowledge institutions – such as the Amsterdam New Media Association. The local government is also involved in a project to provide a new neighbourhood with ICT broadband infrastructure (Cyburg).

As late as 1995 the *Groningen* City Council decided to develop an ICT cluster. Several ICT oriented organisations were already present. A number of activities stimulate ICT cluster development, including an ICT business guide, informal networking of ICT companies, firms from other sectors and knowledge institutes, and setting up an acquisition programme for ICT companies. Also, the municipality dedicated two business parks for ICT companies. Most of these plans were implemented during the late 1990s. They led to a rapid growth of employment.

In *Stockholm*, an ICT policy was set up, but only few people know it. There is a focus on cooperation between the ICT sector and educational institutes to increase the ICT knowledge within the region. Another focus is on the diffusion of broadband infrastructures (*Stockab*). The larger firms in Stockholm stated that they had a close cooperation with the local and national government, while the SMEs declared that they had almost nothing to do with any governmental authorities.

Jönköping doesn't have an ICT policy. The companies that were interviewed didn't seem to miss such a policy.

7. DEVELOPMENT PATTERNS OF ICT CLUSTERS: FOUR GROWTH MODELS

Our case studies in eight cities and urban regions revealed large differences of development patterns in the ICT clusters. In this section, we take a first effort to catch the essential patterns of development in typical growth models. In each model, we

look at the interaction between market developments and policy initiatives. For each of the models, we will suggest whether it is applicable to other European cities.

The Irish Growth Model

The development of the clusters in both Dublin and Cork took off as international investment grew very rapidly. Many foreign ICT companies (notably from the US) settled in Dublin, and some in Cork (Apple). They did so because of cost advantages: low corporate taxes and relatively low wages. Ireland's business climate was also improving because of large investments in infrastructure (massively supported by the EU). The English speaking population and Ireland's central geographical position between Europe and the US made it an ideal location for ICT companies from the US.

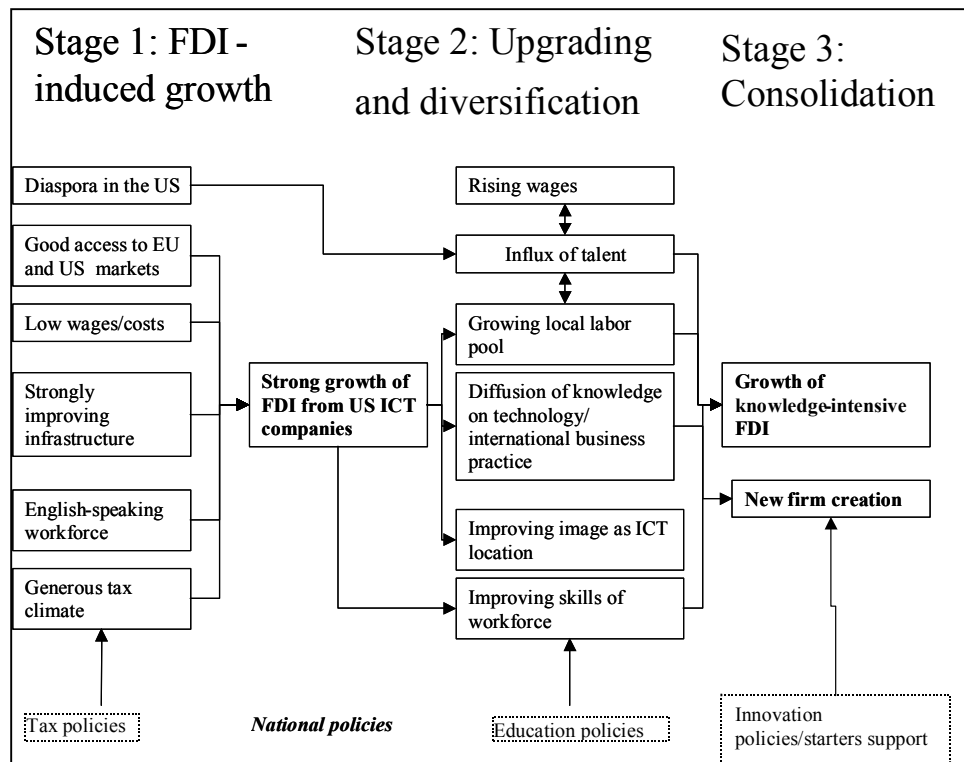


Figure 6 The Irish growth model

The influx of foreign direct investment brought in technological knowledge and international business experience. Irish employees became much better trained, and many spin-offs emerged from the multinationals. At the same time, the educational level of the Irish workforce increased substantially thanks to investments in the knowledge infrastructure. The number of “indigenous” ICT companies started to

grow, the knowledge intensity of operations increased, and the ICT sector became much less a branch plant economy.

In the late 1990s skills shortages occurred, wages were rising, and influx of talent from increased. Also, a further sophistication of the ICT industry can be observed. This is reflected in investments to increase the interaction between knowledge institutes and companies. The downturn of the ICT sector, since 2000, has somewhat slowed down salary inflation, and has led to higher levels of unemployment among ICT graduates.

The ability of policy makers to react quickly to changing demands was displayed by the education sector in the 1990s as skills shortages in the ICT labour market helped to jumpstart new third level courses in computer science and engineering.

In recent years, there have been attempts to increase the indigenous firm base. Government encouraged local managers in multinational firms to spin off their own local software start-ups. Government agencies have helped by providing market information, by organising and subsidising attendance at overseas trade fairs and exhibitions, and by supporting the formation of trade/industry associations. Indigenous companies have helped themselves by setting up subsidiaries in overseas markets.

The Irish model may be adopted by cities in Central and Eastern Europe. In some respects, they have a similar starting position, with cost advantages and proximity to the European market. They might also strongly improve infrastructure, with EU support. If they manage to offer an attractive business climate, they may first attract cost-sensitive ICT investments and then try to upgrade the sector like the Irish Republic is doing now.

The Nordic Capital Growth Model

This model summarises the development in Helsinki and Stockholm. It is propelled by a strong development of industry champions (Nokia and Ericsson), but also by the growth of less known companies (like Sonera in Helsinki). The cities' starting position was favourable. Both cities had a tradition as services centres and as strong

engineering and R&D centres. Both had a highly educated and multi-lingual labour force. One important feature was the early liberalisation of the telecom markets in Scandinavia, which gave an enormous boost to the telecom and software sector. On top, the low population densities in these countries have contributed to an early uptake of mobile communications. The relatively free telecom market invoked competition and innovation among telecom providers, equipment manufacturers and other firms in the telecom cluster, and provided this companies with a competitive edge.

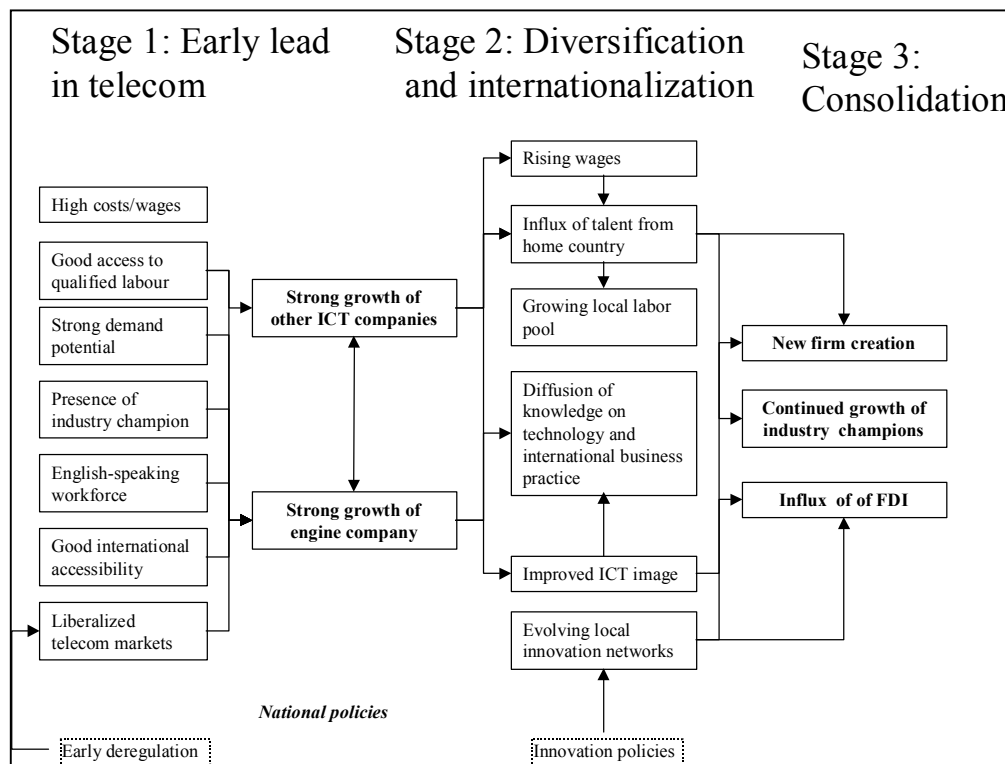


Figure 7 The Nordic Capital growth model

Over time, the ICT image increased, and foreign ICT companies moved in to benefit from the knowledge and resources the place offers. The orientation of the cluster became more and more international, and international business practice trickled down to local firms. The cluster grew strongly and specializations developed. Human resources were attracted to the city from all over the country. Many new companies were founded, and linkages between knowledge infrastructure and business became more intimate. Governments strongly promoted innovative co-operation and entrepreneurship.

At present, labour shortages are emerging. Firms have to attract workers from abroad. Wages and office space rents soar, which puts a natural break on the growth of the

cluster. This stage can be characterized as consolidation. The key policy challenges are how to manage growth, to provide space for business activity, and to ensure a good accessibility.

This model may be applicable to other cities in advanced countries that combine a strong service sector and modern industry. Examples could be Munich, Lyon, or Turin.

The “Peripheral Specialisation” model

This model describes the development pattern of Oulu’s highly specialized ICT cluster. More than in any of the other cases, national and local policies have shaped the cluster. The city did not have a large home market, nor was it located near other markets. This explains its strength in R&D sectors, in which market nearness is less important. National regional development policies, the set-up of a technical university, strong and consistent local policies and a co-operative culture fostered the cities’ cluster.

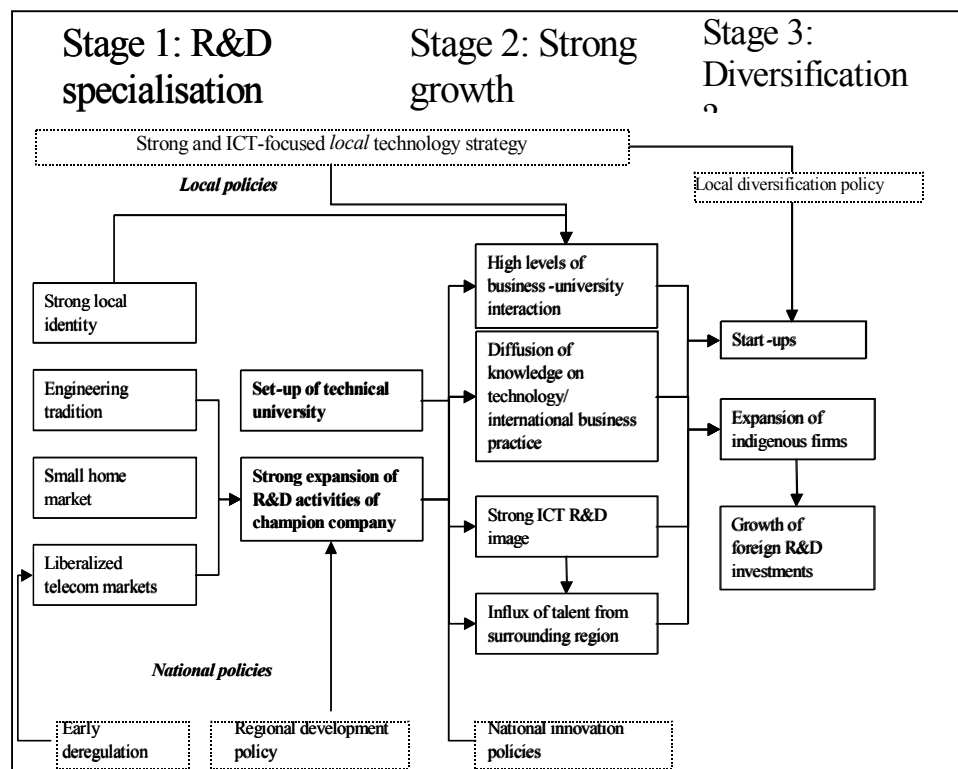


Figure 8 The “Peripheral specialisation” model

Instead of supporting declining industries Oulu region in the 1970 decided to enhance the co-operation between university and industry and rest on its own competence. The establishment of the university of Oulu, the laboratories of Technical Research Centre of Finland and the foundation of the first Science Park in Nordic Countries have been crucial factors to make growth of knowledge-based industries possible in the area. The establishment of Nokia in the region generated a wave of establishment of smaller firms in electronics and later in the software industry. In the 1990s, Oulu's fame as technology competence centre also attracted foreign companies. The city grew rapidly during the 1990s, and managed to attract professionals mainly from the northern part of Finland.

One of Oulu's challenges is to reduce its dependency on ICT and R&D. Therefore, in the coming years, the city and the region want to diversify the economy. This strategy is elaborated in a Growth Agreement, and backed by all the important actors in the region.

This model may be applicable to other peripheral regions that do not have a strong home market but that are able to create a strong local knowledge infrastructure.

The International Service City Model

This model represents the development of the ICT cluster in Amsterdam. During the 1990s, Amsterdam has capitalized on its strength as international business city, which was reflected in the development of the ICT and new media cluster. Amsterdam's economic structure has some features that enabled strong growth during the 1990s. It had a very strongly developed financial sector, and a big media sector, that provided a strong local demand potential. This made Amsterdam a suitable location for new start-up companies. Moreover, the market accessibility from Amsterdam is first-class. It has excellent connections, among others via Schiphol international airport. This, in combination with a generous tax and business climate, has made Amsterdam an interesting location for foreign ICT companies. The city's young, dynamic and

international image helped to attract many highly-skilled employees from all other parts of The Netherlands, and also from abroad.

Although the R&D component in Amsterdam's ICT cluster is weak compared to other cities in our sample, scientific research has indirectly played an important role in the cluster's development. Back in the 1980s, Amsterdam's university gained a central position in electronic infrastructure, as a node of the networks linking universities worldwide. During the 1990s, the Internet developed beyond the scientific community and became increasingly commercialised. The Amsterdam Internet Exchange was founded, and Amsterdam developed as a prime European Internet node. This attracted many telecom companies to the city in the late 1990s.

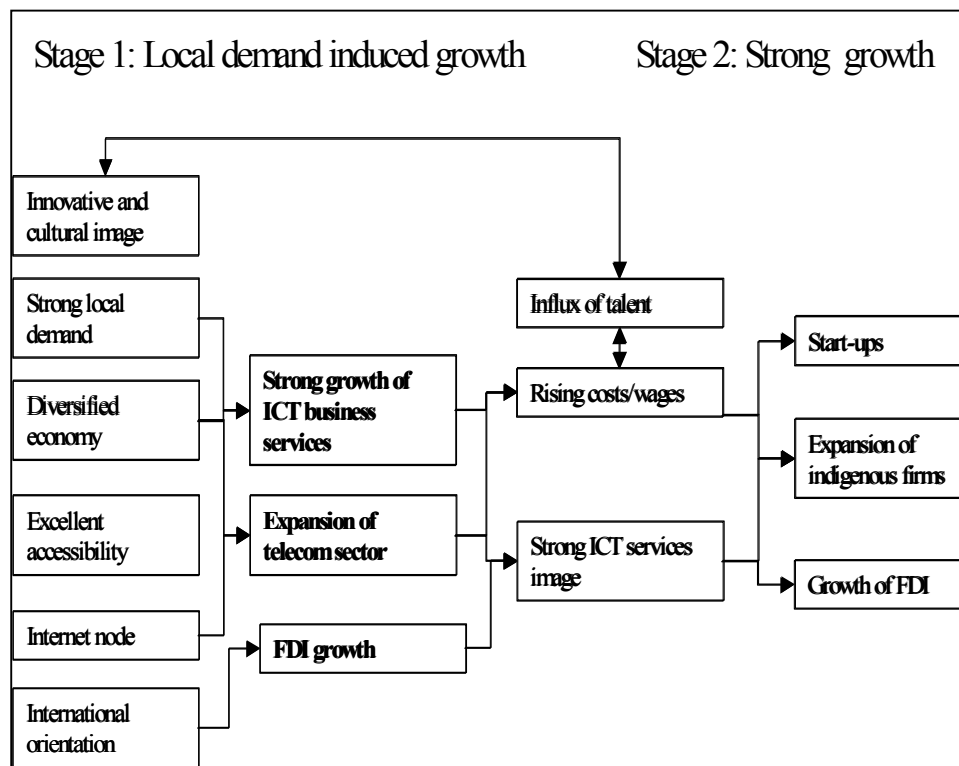


Figure 9 The International Service City model

During the second half of the 1990s, the growth of the ICT sector has taken off: both the number of start-ups and international companies grew rapidly. Interestingly, the municipal government didn't conduct an explicit policy to stimulate these business sectors. As a result of increased demand in the late 1990s the costs of land, office space and labour began to rise rapidly. This led to a dispersion of companies from the city centre to the suburbs and surrounding municipalities, where costs are lower.

This model may be applicable to other cities in advanced countries that have a strong service sector and modern economy. Examples could be London, Frankfurt, and Brussels.

8. CONCLUDING REMARKS

In this study, one of the ambitions has been to show the diversity of Europe's information society. This report fulfils at least part of that ambition, by analysing eight stories of ICT clusters in different circumstances, and unravelling causes and effects of the clusters' development during the 1990s. As each city is unique, each of our case cities have developed a unique ICT cluster. Nevertheless we were able to draw some generalisations in the form of *growth models* that could be helpful as a set of roadmaps for ICT cluster policies. Additional case studies will be needed to assess whether these development models are applicable to other cities in the EU as well, and to what extent they need refinement.

Notes

¹ Average of imports and exports.

² Data apply to the urban regions. During the 1990s data collection about the ICT sectors hasn't been harmonised across the EU. This explains why in some cases data are missing.

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