ICT loves agglomeration: the urban impact of ICT in the Netherlands

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Abstract

Information and Communication Technology (ICT) has had an undeniable impact on our society. Some people argue that technology has projected us onto a new wave of social and cultural change. Nevertheless, despite the growth of technology and the social significance of its applications, we have only a poor grasp of its actual impact on the use of physical space. The key question addressed in this paper is therefore: how will ICT influence the spatial-economic patterns of business activities in the Netherlands? In offering answers to this question, the paper develops a conceptual framework that distinguishes two roles of ICT in spatial-economic development: that of a 'motor', enhancing productivity and encourages the development of economic sectors, and that of an 'enabler' (of e-work, e-commerce and e-business), which may lead households and firms to adopt a different attitude to space requirements. The paper is based on a thorough survey of the current literature on the subject, the results of a recent survey of ICT's impact on society, and original empirical research into specific factors such as ICT companies' location preferences and the willingness of knowledge workers to commute. The paper presents an assessment of the usefulness of these concepts in terms of the Dutch situation, both today and in the future.

We conclude that Information and Communication Technology has not yet had a marked visible impact on the use of space. To the contrary, despite predictions neither Dutch companies (particularly those in the ICT sector) nor knowledge workers display any unusual degree of mobility at the local or regional scale. ICT does not function as a

perfect substitute for ‘traditional’ behavioural patterns. Nevertheless, there are clear indications that the ‘spatial order’ of the Netherlands is likely to change. Although it is likely that ICT will consolidate underlying spatial patterns, on the regional aggregate changes are occurring within those patterns. While (inner) cities have traditionally been the breeding ground for new ICT companies, this function has now largely been taken over by the outlying city regions, in which multiple clusters of economic activity are emerging: a process of ‘splintering urbanism’. However, despite this regionalized pattern of deconcentration, the traditional city centres continue to fulfil a number of essential functions. These centres remain the meeting places, and the shopping and entertainment centres for businesses and households (the ‘Consumer City’). In the processes of deconcentration and multimodality, ICT should be seen to play an important facilitating and strengthening role.

INTRODUCTION

Background

Information and Communications Technology (ICT) has had an undeniable influence on our society. ICT has a growing presence: 80 per cent of the Dutch population have access to a computer, while some 65 per cent also have Internet access. More than 90 per cent of all businesses own one or more computers. The entire economy relies on the support of ICT. For its part, the ICT sector has developed to become an important economic activity over the past decade. Between 1995-2000, its share of the total economy (in production value) grew from 4.5 per cent to almost 6 per cent. In the Netherlands, it is the ICT services sector that has accounted for most of the economic growth in the ICT industry as a whole. Between 1995 and 2001, there was a particularly marked increase in the employment volume within ICT services, with the number of people working within the sector rising by 77 per cent, from under 132,000 to more than 233,000. This increase is considerably greater than that in employment volume for the ICT production sector (stable at 68,000 since 1995). The transition of the Dutch economy towards one based on services and information is reflected in the increase in the number of people whose daily work is conducted at the computer monitor. In the mid-1990s, approximately half the active working population fell into this category. By 2001, the figure had increased to over sixty per cent (Statistics Netherlands, CBS, 2003). There has also been a clear intensification in the (existing) use of ICT: the volume of Internet data traffic increased more than one hundredfold between 1997-2002 (CBS 2003: 11).

We stand on the threshold of a new wave of socio-economic developments brought about by ICT. Some believe that we have already been engulfed by that wave. It is comparable to the economic and spatial dynamic of the post-war period, when demand for consumer durables such as the television, refrigerator and the private car burgeoned. ICT could well bring about major changes to the spatial-economic structure of the Netherlands, and in the behaviour and functioning of Dutch households and businesses. Much has been postulated about the mobility-restricting effects of e-commerce and e-business, about ‘footloose’ companies, about teleworking, about urban centres as the

focal points for offices, about the manner in which ICT will facilitate the service sector in general and the resultant decline of the industrial and agricultural sectors.[1]
In this paper, we examine the extent to which the new developments within, or caused by, ICT are indeed likely to bring about major societal change. Is the behaviour of companies and households really going to alter so dramatically, or will the information era merely serve to enhance the efficiency and effectiveness of the society that we already have?

The central question of this paper is therefore:

How will ICT influence the spatial-economic patterns of business activities in the Netherlands?

[1] These various theories prompted the Netherlands Institute for Spatial Research to conduct research into the spatial impact of ICT: Van Oort, Raspe, Snellen (2003) De Ruimtelijke Effecten van ICT ['The Spatial Effects of ICT'] Rotterdam, NAI Uitgevers.

Conceptual framework

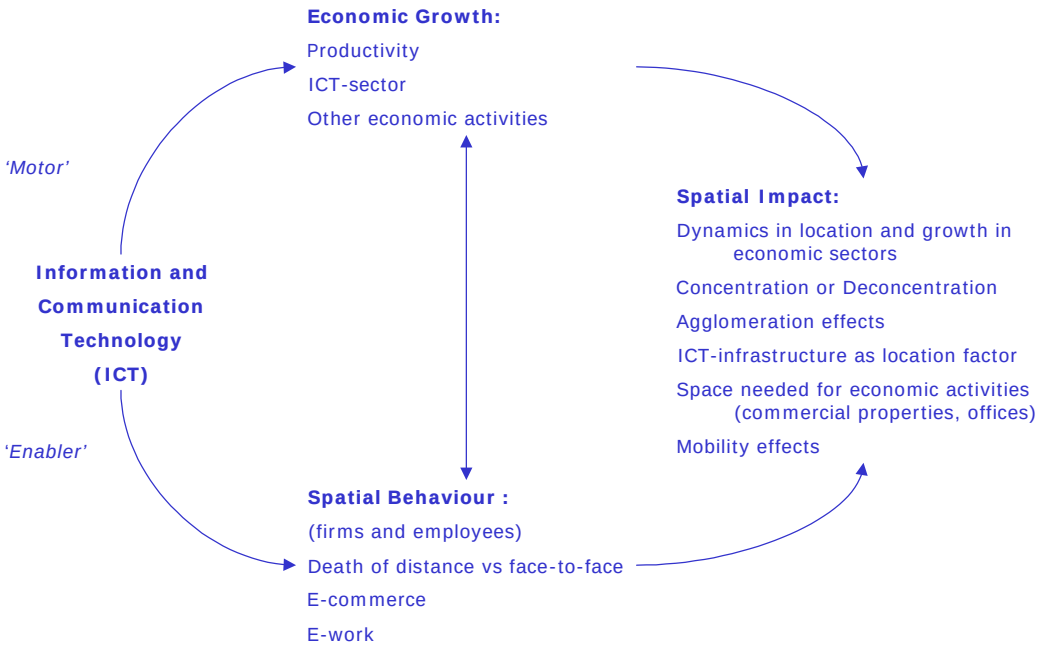
In this paper, we have opted to focus primarily on the economic dimensions of the spatial impact of ICT. Clearly, ICT can have an effect on space usage in several ways, as summarized by Figure 1.1. In the general sense, ICT has an effect on economic growth in terms of its influence on existing business processes, on the organizational structure of companies and business sectors, as well as on households, insofar as they are also physical occupants of space. Technology is hence a *motor* of economic growth and can bring about improvements to productivity. The ICT sector itself can grow, or other sectors to which ICT makes a substantial contribution can grow. ICT therefore accelerates the developments within the existing spatial and economic structure of the Netherlands, while also making such developments more effective. This particular function of ICT is central to the first section of this paper.

Besides being a 'motor' (active), ICT can also be an 'enabler' (a catalyst). Technology makes certain changes, such as teleworking, possible in such areas as the spatial behaviour of organizations and their staff. This function is considered in detail in Section 3. Many observers have predicted that companies are likely to become 'footloose' as the result of the 'death of distance'. However, it seems that traditional 'face-to-face' contact is of fundamental importance to economic systems. We discuss spatial-economic effects in the context of the regional economic distribution pattern of the ICT sector in the Netherlands. We also examine how the concepts of teleworking are being applied in the country, considering the possible effects in terms of the claims on space made by economic activities.

The final section is devoted to a summary from which we may deduce that the interaction between ICT and spatial-economic development is a dynamic one. Spatial and economic policy, and the research required to formulate such policy, must acknowledge that there are various types of urban area, each displaying different types of economic development. The relevance of the various processes renders it essential to gain a full understanding of different levels of scale simultaneously. Such understanding is currently lacking in several areas of policy and in the research into the (economic) functioning of cities and urban regions. The common denominator of the analyses described in this paper is that the locations examined are clustered in areas which are larger than the traditional urban settlement, and are larger than even the urban

agglomeration as defined by official policy. Future research to be conducted by the Netherlands Institute for Spatial Research into the relations between ICT, economic development and urban configuration will devote further attention to these dimensions.

Figure 1 Conceptual Framework



Source: Van Oort, Raspe and Snellen (2003)

THE ICT SECTOR IN REGIONAL ECONOMIC GROWTH

This section is concerned with the regional-economic growth of the ICT sector. The ICT sector may be described as a young industry, based entirely on a new technology and a relatively codified body of knowledge which is stored in computers and in the minds of highly-trained staff. Accordingly, ICT companies are not reliant on investments in commercial real estate or capital goods made in the past. Many observers believe that their choice of location is therefore practically unlimited. In fact, the ICT sector tends to lead the way in terms of the location factors for business activities. Because the use of applied (ICT) technology is greatest in this sector, it is here that the 'information economy' has penetrated most deeply and is most fully integrated. ICT companies and their staff (often referred to as *knowledge workers*) are therefore 'by example' often assumed to be 'footloose'. (Florida 2002; Gottlieb 1995).

As yet, relatively little is known about the spatial consequences. However, ICT, as a process and force in improving productivity, does influence production methods and organizational processes, which in turn will have a clear spatial effect. Moreover, not only do ICT applications affect productivity of the overall economy (Van Leeuwen and Van der Wiel 2003), but the growth of the ICT sector itself must also have a significant spatial impact. The emergence of new companies will inevitably give rise to claims on space. There are spatial differences in the growth of the ICT sector. Information regarding productivity trends, traditionally one of the main indicators of economic development, is not available in the Netherlands at any spatially disaggregated level of scale. Accordingly, economy growth is largely gauged in terms of the (change in) the number of companies active, and the employment they provide (Van Oort 2003) rather than developments in terms of labour productivity. The analyses in this section focus on spatial patterns of employment in different perspectives.

The spatial distribution pattern of the ICT sector in the Netherlands in 2000

When we plot the ICT sector on the map, we see clear spatial differences and specializations. For the Dutch situation, this process has already been undertaken by

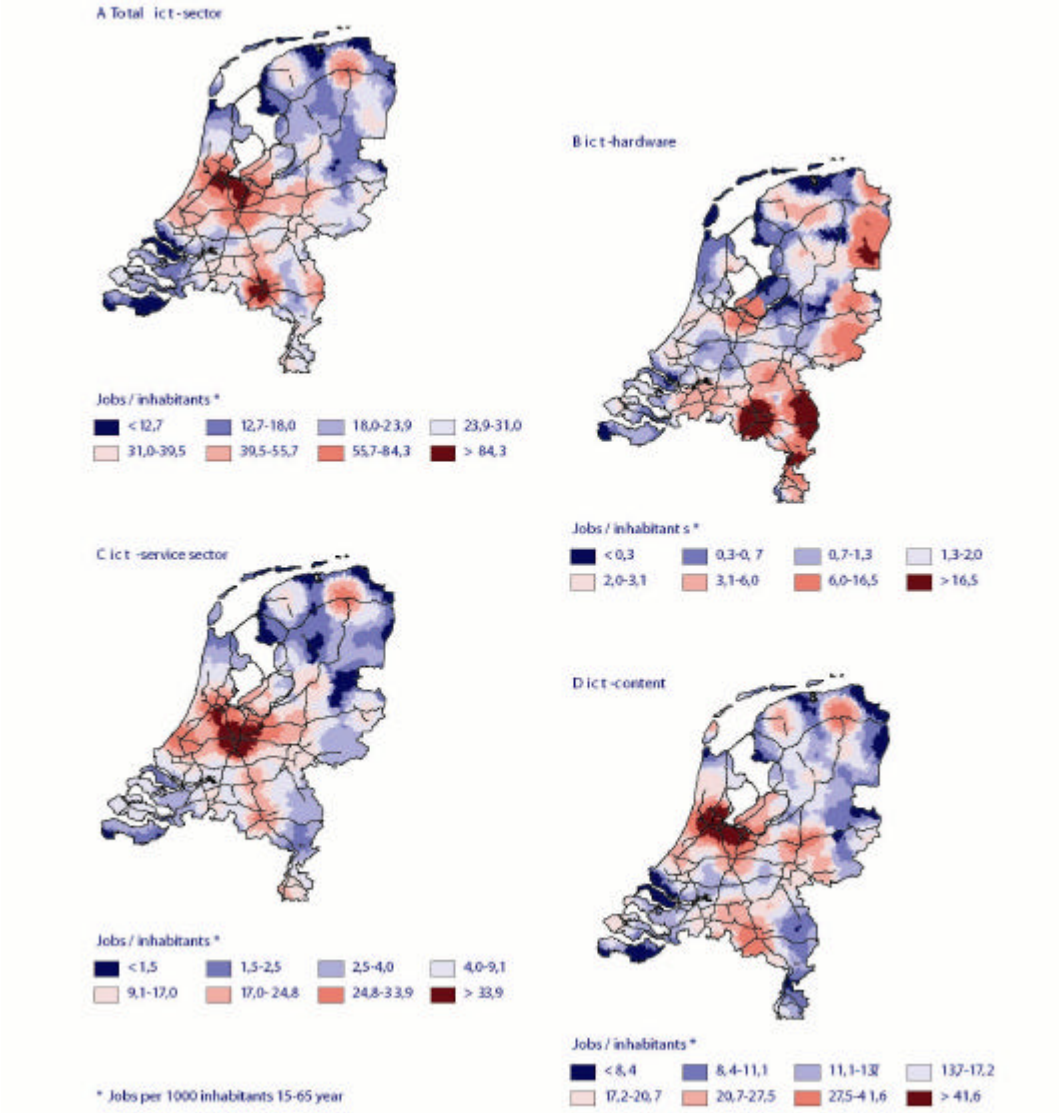
Louter (2001), CBS/Statistics Netherlands (2002, 2003).[2] These studies reveal that the ICT sector (including and excluding the content companies) have two spatial concentration points: the northern part of the Randstad (Amsterdam-Utrecht region) and the Eindhoven region. The southern part of the Randstad also scores reasonably well, but substantially less so than the north. A classification by sub-sector shows the spatial specializations of the ICT sector (Louter 2001), the distribution of which is represented in Figure 2.[3]

It should be noticed that hardware production is currently very strongly represented in the Eindhoven region and in Noord-Limburg. Relative specialization is particularly high in several areas outside the Randstad. In a number of cases, this is due to the presence of just a few, or at the most a small cluster, of high-tech companies in areas with low employment density. The ICT services sector is particularly well represented in the Utrecht region, which includes a large number of computer software companies. The ICT content sector is strongly represented in the Amsterdam/Gooi region, notably advertising agencies (Amsterdam), publishers (Amsterdam) and the media (Gooi). This type of activity is surprisingly sparsely represented in the southern Randstad (and particularly Rotterdam). Outside the Randstad, the activities are reasonably well represented in the Eindhoven, Groningen and Apeldoorn-Deventer regions (the latter being notable for publishing houses). Given these specializations, the overall ICT sector (being the total of the three sub-sectors) displays a distribution pattern that is strongly tied to the Randstad (the Western Netherlands), with an 'extension' along the A2 motorway corridor to the south. Moreover, ICT-related activity tends to be clustered in the urban regions.

[2] There are certain differences in approach between the Louter and CBS/Statistics Netherlands sources, in that Louter (2001) states the number of employment positions per 1000 head of population aged 15-65 (the 'working population') while the CBS/Statistics Netherlands study cites the number of ICT companies as a percentage of the total number of businesses active in the Netherlands.

[3] In producing a spatial distribution map, Louter (2001: 13 ff) uses the technique of *potentialization*, whereby the score for each location is considered against those for adjacent locations, corrected for the (physical) distance between them.

Figure 2 Spatial distribution of the ICT sector in the Netherlands (2000)



Source: Louter (2001), TNO Inro, Delft, for the Ministry of Economic Affairs, The Hague

The spatial evolution of the ICT sector in the Netherlands, 1972-1990

According to many observers, it was around 1980 that the fifth Kondratieff Wave of ICT began to be seen. In their local-level study of ICT company location, Bleichrodt *et al*. (1992) examine exactly where the ICT sector emerged in the Netherlands in the early

1980s.[4] At the time, the sector was already prominent in terms of ICT applications in business processes. Figure 3 shows the locations of ICT companies in the Netherlands for the years 1972, 1976, 1980, 1984, 1987 and 1990.[5] We may observe a pattern of diffusion which largely follows the urban hierarchy. At a later stage, proximity effects also play a part. This was originally expressed as the 'filtering-down' theory (Thompson 1968). In the first stage it is the urban regions in the main conurbation (here, the Randstad) which form the breeding grounds for new business development in the ICT sector. In the second phase, the sector begins to disperse and gravitate towards large and medium-sized towns and cities, and then (in the third phase) to cities on the national periphery and relatively rural areas of the diffusion area (Gelderland and Noord-Brabant). The development stops here. Those areas which developed first (the urban regions in the Randstad) maintain their 'head start' over the other development areas in terms of ICT activity. However, concentration does not take place in the major cities, but in a number of suburban outer boroughs and in urban areas outside the largest agglomerations.

The analyses presented by Bleichrodt *et al*. (1992) do not show any convincing evidence of a creation-and-diffusion pattern as suggested by the evolutionary economy ('windows of locational opportunity') theory. In the Netherlands, the sector did not emerge in the relatively underpopulated areas with no clear advantages of agglomeration. However, it may be stated that, once the sector had gained a foothold in the Netherlands, the mechanisms of cumulative growth manifested themselves in line with the evolutionary growth economy prognoses. However, proof for the aspect of discontinuity in the emergence phase, a key feature of the evolutionary theory, is lacking on the basis of the current study (see Weterings 2003).

[4] The study is based on the division of the Netherlands into 276 districts, each larger than the official local authority areas (of which there are 584) but smaller than the forty COROP districts. The 276 districts are based around a (sub)urban development, the requirements being that each district should have a population of at least 20,000 and that the local authority areas included should be adjacent to each other.

[5] It should be noted that it was possible to determine the location of businesses in 1978 and 1984 only where the companies concerned were still in existence in 1990. The maps therefore indicate the pattern of *successful* ICT software companies. The presence of ICT software companies in each area is calculated by dividing the total number of locations into the working population of that area during the research period. The analysis was then based on classifications of: <0.5, 0.5-1, 1-2, 2-4, 4-8, >8.

Figure 3 Location of the ICT sector in the Netherlands before 1972 and in 1976, 1980, 1984, 1987 and 1990

Source: Bleichrodt *et al.* (1992)

Dynamic analysis of new business formation and the growth of ICT companies

A number of more recent economic-geographic theories assume agglomeration effects of economic activity at several spatial levels of scale (Lambooy and Van Oort 2003). Space itself matters. But what is the influence of network externalities once a cluster of ICT activity has been established? And who is responsible for these externalities? Who gains or loses by them? Is, as previously argued, the 'transfer of knowledge' the crucial factor? To what extent do the transmission effects determined and financed by the market play a role? What about spillovers? And to what extent is *the* nature of the agglomeration important? Agglomeration hypotheses taken from the geographic and social disciplines have been subject to an empirical assessment in the recent literature, including that of sectoral ICT clustering at urban level (Van Oort 2003; Van Oort and Atzema 2004). The literature in question emphasizes that the externalities and spillovers within and between *towns and cities* bring about further growth and innovation. Beyond these existing agglomerations, they are responsible for rather less development. Here, a distinction is drawn between spillover aspects related to specialization and those which are due to diversification. Within the former vision, clustering of companies in the ICT

sector will result in a specialized local economic structure dominated by that sector. This offers three advantages: first, the joint employment market creates greater development potential for the companies, with lower recruitment costs and lower sector-specific training costs due to the advantages of scale. Second, many of the ICT companies' input-output relations will be simplified by virtue of the urban setting. The sector-specific clustering renders both customers and suppliers more readily contactable, resulting in lower transaction costs. Third, knowledge spillovers within the urban area must be assumed: unpaid mechanisms of knowledge transfer between knowledge institutes and ICT companies, or between the ICT companies themselves, which result in economic growth within the specialized and localized business column and to the formation of new companies. The specialization hypothesis for economic clustering is very well established within economic geography. The associated agglomeration advantages are known as 'locationalization advantages'.
Recently, a number of researchers have chosen to place the emphasis on the large urban areas with an extremely large diversity of business activity, involving many different sectors. Consultancy, distribution, wholesale, retail, banking, insurance, catering, hospitality, education, research: all tend to cluster, particularly in the major urban centres. The employment market is at its broadest (although perhaps somewhat less specialized) and most diverse in the large urban areas. Moreover, the urban regions present the most creative setting, leading to economic growth and spillover effects for ICT companies. Advantages associated with urban diversity are termed 'urbanization advantages' in the tradition of geography. The influence of these agglomeration factors in terms of the formation and growth of ICT companies in the Netherlands has been researched by Lambooy and Van Oort (2003).

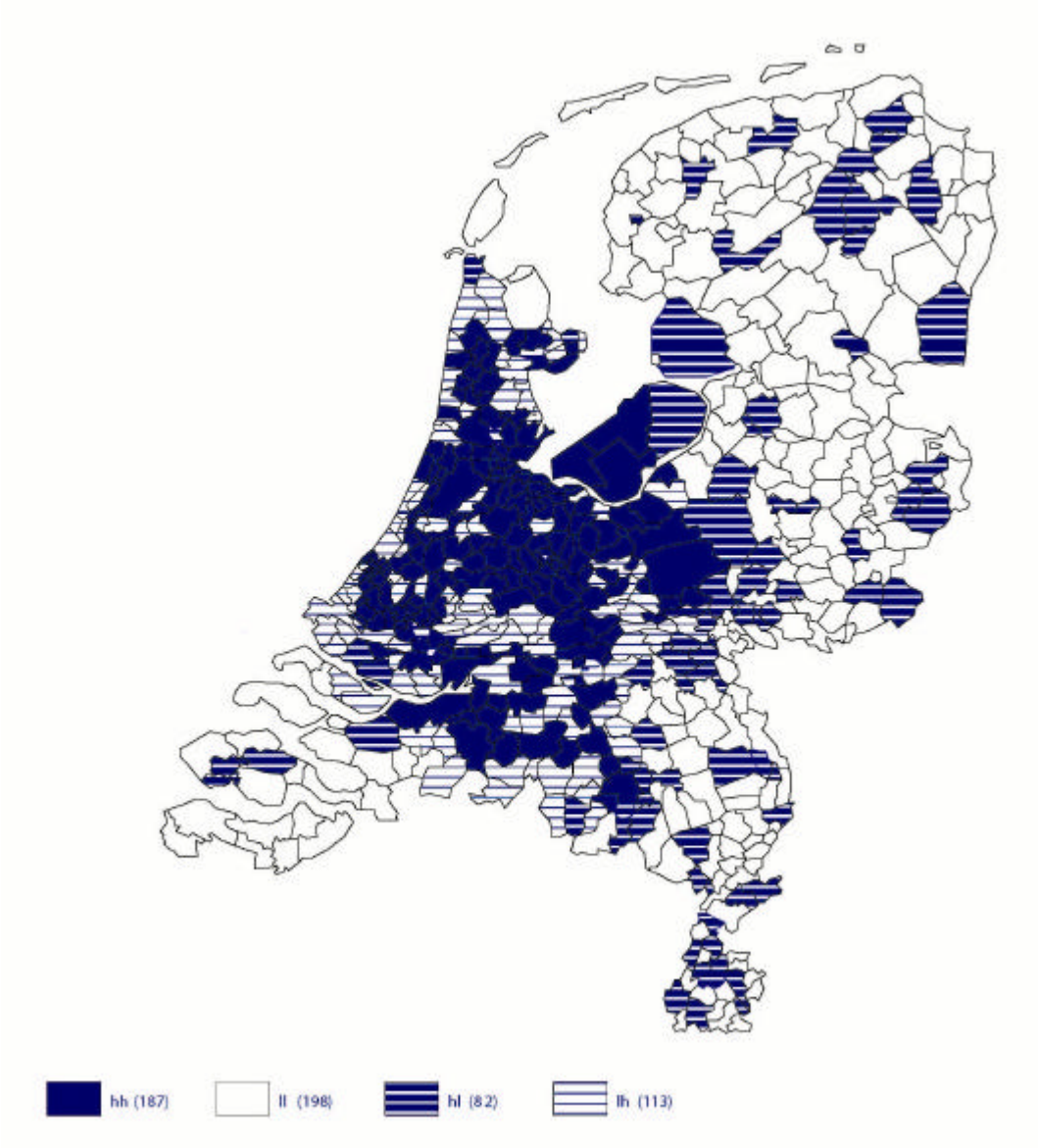
Figure 4 shows the individual towns and cities in the Netherlands in which a relatively large number of ICT companies were to be found during the period 1996 to 2000.[6] ICT companies as a proportion of the total number of businesses in any one town is shown as a comparison with the national sectoral division (the 'location quotient'). Figure 4 further indicates pairs of neighbouring towns (based on distance from centre to centre) in which each attain a high score in this regard: the HH score. This enables clusters

[6] The four largest cities were divided into three-digit postcode areas. Eventually, 580 spatial units in were considered in the analysis. The definition of 'ICT activity' is that applied in Van Oort & Atzema (2004).

(agglomerations) of high scores to be identified in spatial terms. Similarly, areas which, taken as a whole, have a low density of ICT activity are identified by means of LL scores. HL scores represent concentrations, ('hotspots') of high scores locations in an area with relatively low scores, while LH scores indicate a localized 'barren area' in a region which generally scores quite highly. In the Netherlands, there are relative concentrations of ICT companies in the Randstad, with extensions seen in the direction of the Gelderland Valley (Veenendaal) and Eindhoven. The cities of Groningen, Enschede, Zwolle, Nijmegen and Maastricht represent typical concentrations within the national pattern.

It will at once be observed that there is a marked difference between Figures 5 and 6. Figure 5 shows how employment has increased further to the formation of new companies between 1996 and 2000. The A2 motorway corridor, which passes through the northern part of the Randstad (Amsterdam-Utrecht) towards Eindhoven and the Gelderland is an obvious contiguous cluster region. The southern part of the Randstad (Rotterdam-The Hague) shows a clustering of low scores. Apparently, the location conditions in this region are seen as less favourable than elsewhere. Outside the Randstad and the intermediate zone (Gelderland Valley Flevoland, Noord-Brabant) it is the same towns as in Figure 4 that are to be characterized as 'concentrations'.
Figure 6 focuses on the growth in employment in ICT companies that already existed prior to 1996. In absolute terms, the ratio of employment growth between new companies and established companies is 4:1. The new companies are responsible for a large part of the dynamic in the relatively young ICT sector. A much more fragmented pattern is to be seen in this figure, with high cluster scores in the northern part of the Randstad, in the suburban areas, the medium-sized towns of the southern part of the Randstad (Zoetermeer, Woerden) as well as in Twente and Midden-Limburg.

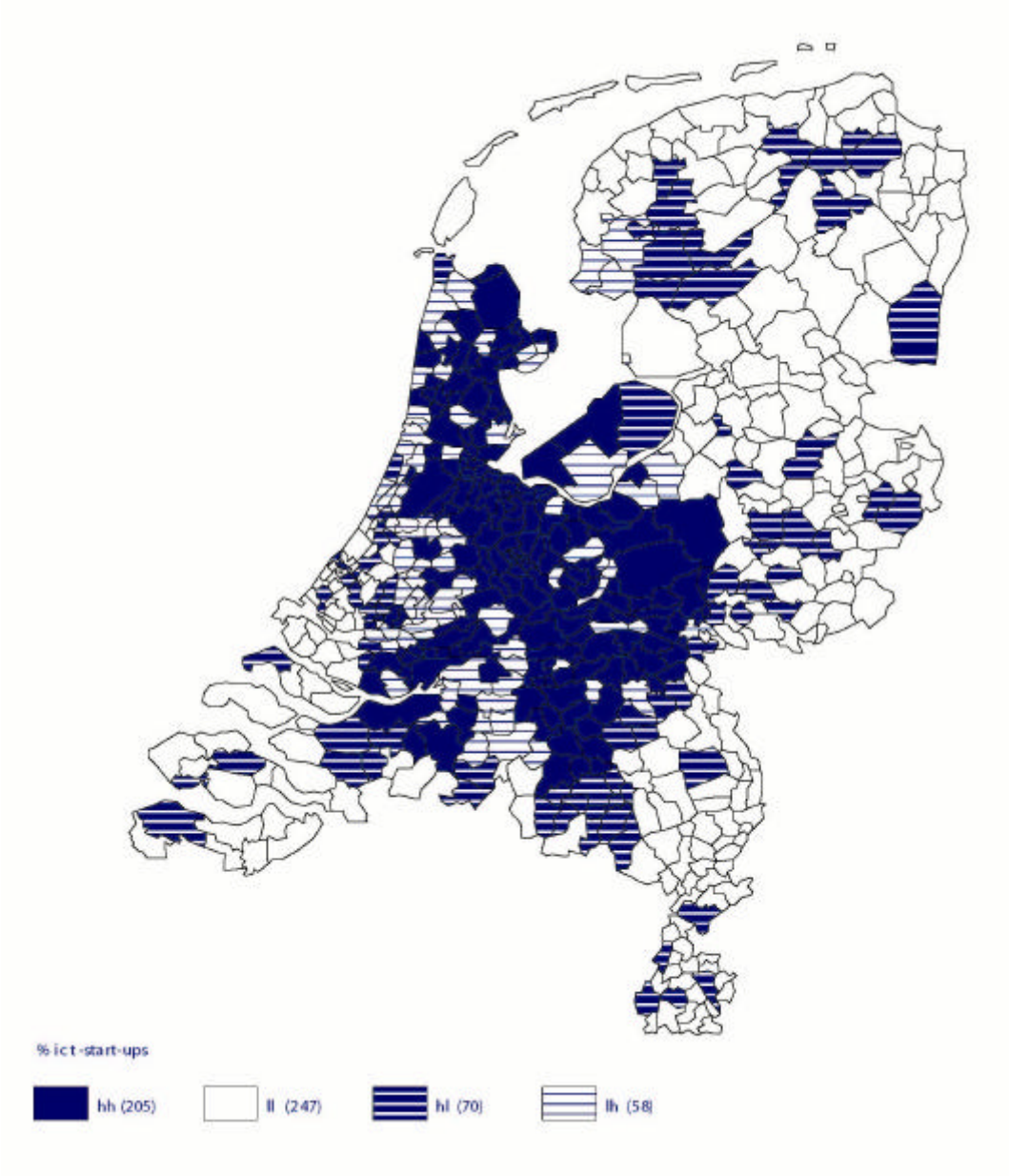
Figure 4 Relative presence of ICT companies in the Netherlands (location quotients, average 1996-2000)



Source: Van Oort and Atzema (2004)

Note: ICT companies were identified by means of the Yellow Pages directories for the years 1996-2000 and the National Employment Register (LISA). The selected sub-sectors were: hardware production (9,154 employees), software production (46,196), wholesale distribution of ICT products (27,603), retail distribution of ICT products (4,443), Internet, (multi-)media and telecoms (35,722), data and automation centres (10,701), ICT consultancy (54,498) and other ICT services (3,149). In the period 1996 to 2000, an average of 191,466 people were employed by approximately 18,000 companies in the ICT industry in the Netherlands.

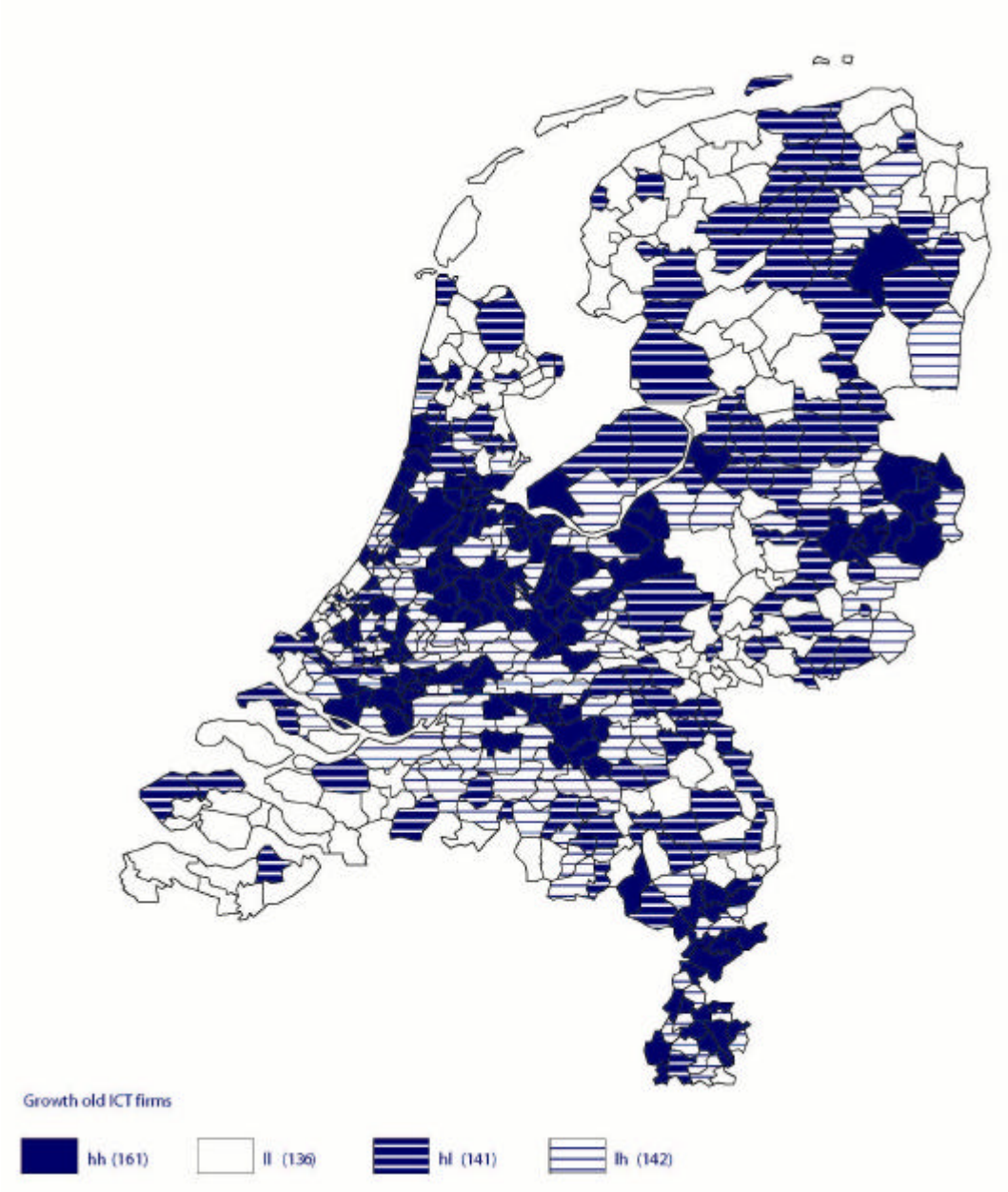
Figure 5 Employment creation by new ICT companies (1996-2000)



Source: Van Oort and Atzema (2004)

Note: The data represents the average annual employment in newly-formed ICT companies. The main source for this information is the National Employment Register (LISA). This comprises 18 regional registers, whereby companies relocating between the regions are regarded as a *new* company in one and a *discontinued business* in the other. However, such interregional migration is of extremely limited extent in the Netherlands.

Figure 6: Employment growth in ICT companies formed prior to 1996 (1996-2000)



Source: Van Oort and Atzema (2004)

Note: The figure shows the logarithmic growth (i.e. adjusted to discount incidental major fluctuations) in the average annual employment for the period 1996-2000.

These figures demonstrate that the life-cycle phase of the companies is a marked differentiating factor in the spatial cluster analyses for the growth and formation of ICT

companies. When viewed in combination with the analyses of spatial distribution at the higher level (i.e. differentiating between city / Randstad / intermediate zone / national periphery as well as between urban centre / suburban/ other areas) and linking such analyses with the explanatory factors associated with externalities (degree of local specialization and diversity), we observe a number of interesting model outcomes, as identified by Lambooy and Van Oort (2003).

New ICT companies prefer to establish themselves in urban areas in which the degree of specialization in the ICT sector is already high, and in which a large degree of sectoral diversity creates the conditions for better business functioning. A relative over-representation of business-to-business service providers in any town or city is likely to influence the ICT companies' location preferences significantly, while a preponderance of non-business service providers will have a negative effect.

The major urban agglomerations (having a central city with suburban satellite towns) seem to offer a good combination of all externality variables. All the connecting factors identified by Lambooy and Van Oort (2003) in their empirical analysis come together most forcefully in these functional regions, compared to the conditions prevailing in towns or cities which do not form part of such a region. Moreover the regimes of Randstad / intermediate zone / national periphery appear to differ significantly in terms of externality variables. The Randstad, and to a lesser extent the intermediate zone, seem to differentiate themselves in a positive sense, the Randstad in all variables and in the intermediate zone in certain aspects, such as sectoral diversity.

The conclusion is therefore that differentiation between ICT companies by life-cycle phase (new versus existing) helps to create a better understanding of agglomeration processes in relation to externalities. Careful examination of the relationship between growth externalities, new business formation externalities and space (agglomeration) shows that clear relationships between core and periphery do not exist at every level. Medium-sized towns in the intermediate zone of the Netherlands ('Gelderse Vallei', Arnhem/Nijmegen, Noord-Brabant) offer equivalent, and occasionally better, conditions for economic dynamics that the major cities or towns in the Randstad. Both economic geography and spatial economy fail to take the *interaction* between different spatial

levels of scale into account, while these would seem to be of great significance, albeit at present in the modelling of the ICT dynamic.
A further important conclusion is that agglomeration effects in the ICT sector are not clearly linked to localization advantages (ICT specialization) or urbanization advantages 'in isloation'. At various levels of scale, *both* appear to be important: they complement each other. However, the Lambooy and Van Oort (2003) study does suggest that the location pattern of new ICT companies in the late 1990s developed along linear, path-dependent structures, whereby agglomeration advantages did indeed play a significant part. There is no evidence of spatial discontinuity on the part of 'footloose' starters, as predicted by evolutionary economic development theories.

ICT INTENSITY AND LOCALISED ECONOMIC DEVELOPMENT

The former paragraph dealt with the spatial economic patterns of the ICT sector. This paragraph takes the role of ICT as a 'general purpose technology' into account. ICT is not only in the ICT sector, but in all economic activities (with different intensity).

The recent study by Van der Laan and Van Oort (2003) examined the penetration and usage of ICT by all 49 sectors in the Netherlands, and the influence of ICT on employment development within those sectors for the period 1991 to 1997. This approach is more appropriate to the vision of ICT as a 'general purpose' technology, whereby all sectors (including, say, agriculture, personal services and construction) have to some extent experienced the effects of automation in working processes.

Statistical information concerning the use of ICT within Dutch organizations is relatively short in supply (Van der Laan 2002). This is certainly the case within the realm of spatial research. Van der Laan and Van Oort (2003) apply a more objective assessment method for ICT penetration in organizations, using a newly developed indicator for the purpose. This enables ICT penetration and usage to be plotted at an extremely detailed spatial level of scale across a number of years. The first step in doing so is to determine the number of computer monitors in use in each sector, information which is available from CBS/Statistics Netherlands. Here, standalone PCs as well as linked (network) PCs and terminals are included. The second step involves establishing an 'ICT index' per employee in each sector, by dividing the total number of computer

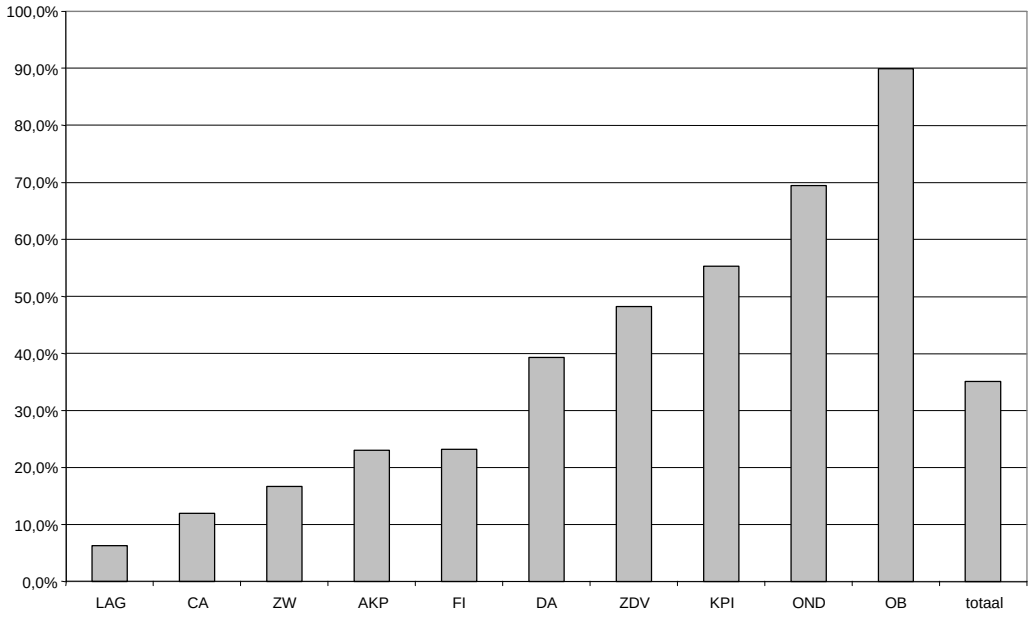
monitors into the total number of employees in that sector (this figure being derived from the National Employment Register, LISA). For each sector, the ICT index then indicates the number of monitors for each employee. For example, where the resulting index is 0.50, this indicates that half of the staff in the sector concerned have access to a computer. Of course, this does not in itself give a full indication of actual ICT use, as it will remain unclear just how often, or for what purpose, the ICT facilities are used. However, for the purposes of spatial studies, the index does indicate which regions may be said to form part of the 'information society'.

Figure 7 indicates the number of computer monitors per employee in 1997, for the working population as a whole and broken down by sector. The figures in the last column reveal that, for the Netherlands as a whole, an average of 35 per cent of the working population have access to a PC in the workplace. As may be expected, the index varies considerably from sector to sector. In agriculture and mineral extraction (6 per cent) and consumer activities (12 per cent) it is extremely low. Education and, more especially, public administration are at the opposite end of the spectrum with indices of 69 per cent and 90 per cent respectively. It is interesting to note that the high scorers are largely to be found in the public sectors. The government cannot therefore be said to be lagging behind the private sector in terms of ICT usage. The business-to-business services sector and the knowledge-intensive process industry (e.g. chemicals) also have relatively high scores.

In their analysis of the spatial developments of ICT use, Van der Laan and Van Oort (2003) apply two hypotheses. According to the first, distance will still form an inhibiting factor for spread, even though ICT has served to lower the transport costs of information. Accordingly, there is no overall 'footlooseness' nor 'death of distance'. Rather, spread - where it is to be seen at all - will remain confined to the areas close to the major cities. The theory here is that, due to the increasing supporting function of ICT within business, forming of networks will be the prime factor. Because physical proximity remains important to network-forming, the spatial options of ICT users will continue to be limited (Van Oort and Van der Laan 2001). The second hypothesis assumes that spread, where seen in and around the major urban regions, will focus primarily on the deconcentrated centres of the expanded and multi-centred regions. In

terms of ICT use, a multi-centred urban structure will therefore emerge. Like the process of ‘splintering urbanism’ that Graham and Marvin (2001) introduced.

Figure 7 ICT diffusion: availability of computer facilities to each employee per sector in the Netherlands (number of monitors in relation to the number of employees in each sector; %-1997).



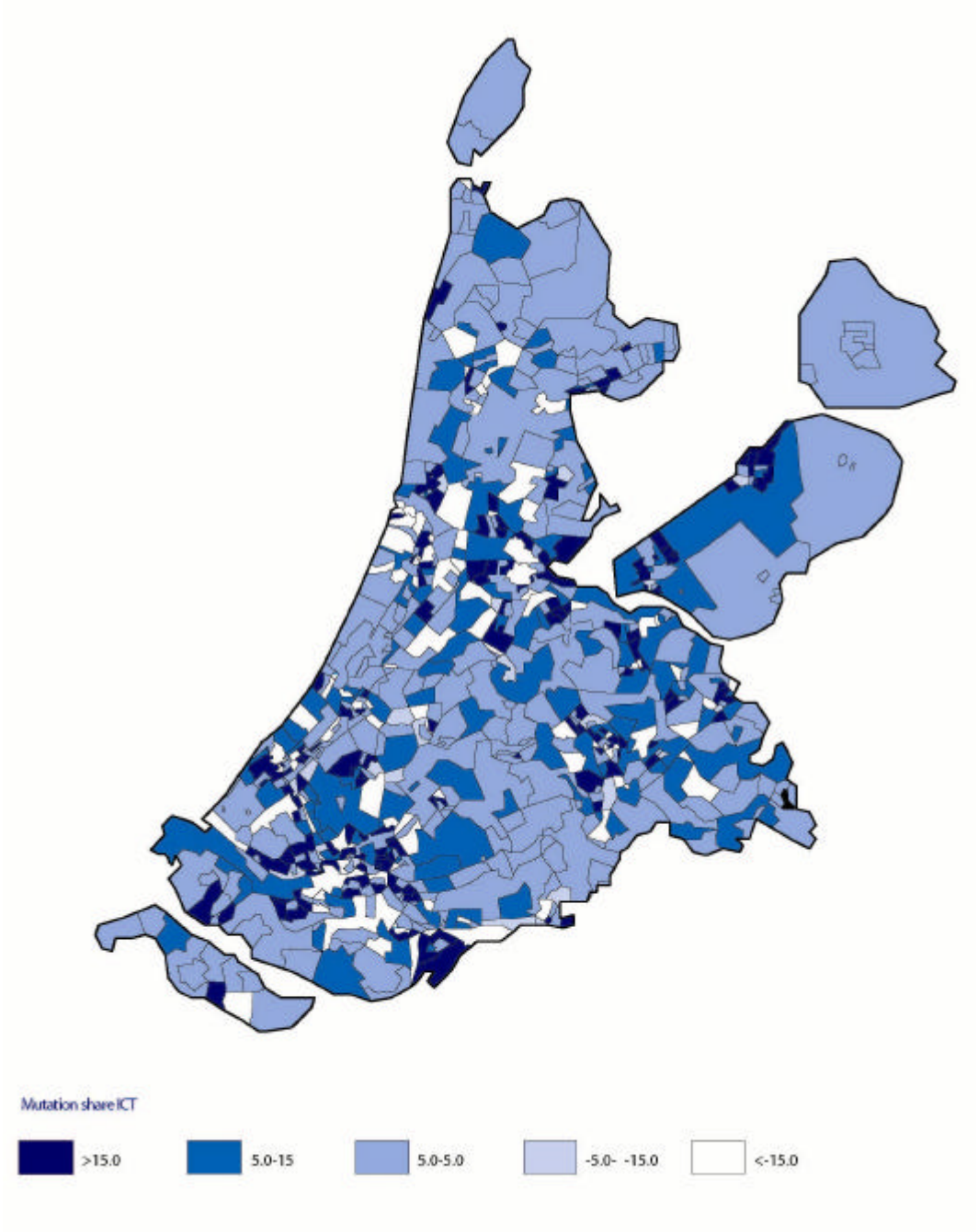
AKP	=	Labour and Capital Intensive production	CA	=	Consumer oriented activities
KPI	=	Knowledge intensive (proces-)industry	OB	=	Public Administration
DA	=	Distribution	OND	=	Education
ZDV	=	Business Services	FI	=	Physical Infrastructure
LAG	=	Agriculture and Mineralogy	ZW	=	Care and welfare

Source: Van der Laan and Van Oort (2003)

Based on these two hypotheses, some notable conclusions with regard to spatial developments in ICT usage can be drawn, as illustrated in Figure 8. This figure shows the development of ICT use at postcode level in the western Netherlands, for the period 1991 to 1997. The first assumption, that the geographic spread of ICT-related employment will be limited must, in the case of the ‘residential and business areas’ (a term applied by the Ministry of Housing and Spatial Planning at a low level of scale in order to create the typology of areas and neighbourhoods in figure 8) be rejected. The central urban

areas are losing their share of ICT-related employment in the 90-ties, while the more remote ‘green urban’ areas this share increases proportionately.

Figure 8 Spatial distribution of ICT-dependent business activity in the western Netherlands, 1991 - 1997



Source: Van der Laan and Van Oort (2003)

The second hypothesis applied in the study is that spread will mainly be observed in the deconcentrated centres within large-scale multi-centred urban regions (as described by Graham and Marvin 2001). This is confirmed by the pattern seen in the western Netherlands. The inverted 'U' curve that applies to the relationship between distance and growth for the Netherlands as a whole is seen here too, in an even more distinct form. Moreover, a polycentric urban structure is indeed emerging. This is due not only to the growth of centres which are at greater distance from the older, traditional city centres, but also due to the development on the outer boundaries of the older centres. This calls for the hypothesis to be redefined somewhat, in the sense that polycentricity not only depends on growth areas at a distance, but also growth areas somewhat nearer at hand. The limited 'footlooseness' and the tendency towards multiple centres give rise to the large-scale urban area, whereby sections of the (former) urban fringe and more remote new centres form the main sites of growth. This development should be facilitated by spatial and infrastructural policy or, where the growth is considered undesirable, should be actively managed. In our concluding section, we shall devote further attention to the spatial patterns of developments in ICT usage, as revealed by Van der Laan and Van Oort (2000).

Spatial-economic growth in the Netherlands further to an ICT impulse?

To date, no specific scenarios or prognoses have been produced with regard to the spatial-economic growth of ICT or the ICT sector in the Netherlands. Nevertheless, some parallels may be drawn from the long-term scenarios produced by the Netherlands Bureau for Economic Policy Analysis (CPB 1997), in which such factors as differences in the rate of technological development and the growth of different economic sectors are taken into account.[7] Given that these scenarios present different expectations with regard to sectoral structure and growth, they also infer different expectations with regard to the influence that ICT will or can have on economic development. The future spatial impact of ICT can then be deduced from the CPB long-term scenarios.

Regardless of whether this growth is actually to be seen, Louter (2001) conducted two sensitivity analyses assuming different growth scenarios. First, he calculated the likely

[7] The relevant planning agencies have now started to develop long-term scenarios as part of the 'Prosperity and the Human Environment' project. In most cases, the scenarios are not tied to any particular policy line. It is assumed that policy followed for the past twenty years will remain unaltered.

effect of extra growth (assuming an increase in employment of 0.1 per cent per annum). This reveals the consequences of ICT developments on the overall rate of economic growth (over and above the Global Competition scenario, which is already rather ICT-intensive). Second, he assessed the effects should future economic development rely not on the ICT-intensive Global Competition (GC) scenario, but according to the European Coordination (EC) scenario, which is rather more cautious in terms of ICT development.[8]

Economic growth or shrinkage has a significant effect on space usage. Louter (2001) projects a number of determining factors in this regard. He concludes that extra growth of 0.1 per cent in employment between 1998 and 2020 will result in 200,000 additional jobs, a further space requirement of 1,380 hectares for industrial premises and a further 1,250,000 square metres (gross) office floorspace. In terms of annual development, the 0.1 per cent additional growth in employment will create demand for 65 hectares in industrial premises and almost 105,000 office space per year, over and above the 'policy-neutral' prognoses of the long-term projections.

Louter's second calculation is based on the EC scenario rather than the more ICT intensive GC scenario. Provided all other variables remain stable, this will result in a five per cent *reduction* in employment by 2020, whereby the space requirement for industrial premises will be four per cent lower and that for office space at least eight per cent lower. Here the very much lower growth of the business-to-business services sector assumed by the EC scenario which is primarily responsible for the reduced office space requirement. Any development in line with the less ICT-intensive EC-scenario will have spatially differentiating effects. The (negative) effects will be most acute in the urban regions, and most especially in the urban sector. The negative effects will be proportionate to the size of the town or city concerned. The strongest negative effects will be seen in the Randstad, and particularly within the Randstad ring (road). The western Netherlands and the economic centres will also suffer more than the average for the Netherlands as a whole. In short, the Global Competition scenario, assuming as it

[8] It should be emphasized that the differences between the EC and GC scenarios go further than those based on the effects of ICT alone. Demographic trends, European integration, other (non-ICT) developments and market forces will all be important determinants within scenario-based development processes.

does an ICT-intensive development, will have an effect on the national mix of economic activities that will benefit primarily the urban regions.

ICT AND TELEWORKING

As previously suggested, ICT can have a marked impact on space usage. For example, ICT enables people to 'telework' and 'telecommute', whereby the work moves away from the traditional locations such as offices, to homes and other locations. Many prominent observers of the 1980s predicted that ICT would thus have a revolutionary impact on society. In their books, Toffler (*The Third Wave,* 1980) and Naisbitt (*Megatrends,* 1984) present a summary of their visions, the product of years of observation, about the idea that ICT applications could have radical effects on the way in which working people live. Since the 'second wave' of industrialization, they point out, millions of people commute between their home and the workplace. The 'third wave' which is the focus of Toffler's book, will bring jobs back from the workplace to the home setting (as the centre of society). Spatial patterns could also alter dramatically as a result of ICT. Cairncross (2001) coined the term 'death of distance'. The Economist went on to describe this 'end of geography' as the most significant force to shape society over the next fifty years. Its impact will be comparable with the discovery of electricity. In spatial terms, it could lead to a scenario in which every workplace with access to the worldwide virtual network is a viable alternative to urban office concentrations as a place in which to work effectively and efficiently. Companies will be 'footloose' because ICT will render them less dependent on the local market. They will then be able to seek less expensive locations or those with a better quality of life. For the regions and the regional real estate market, this will have significant consequences. The traditional urban setting may no longer be the automatic choice of location for many companies.

This section examines the question whether space usage really has seen revolutionary changes due to teleworking, as the 'futurologists' predicted. Specifically, we ask whether the practice of mass teleworking really will represent major reductions in the claims on space. [9]

[9] The data quoted in this section is taken from the MuConsult (2003) study, *Monitor ICT, Ruimte en Mobiliteit; de gevolgen van ICT voor ruimtegebruik en transport*. ['ICT Monitor, Space and Mobility: the effects of ICT on space usage and transport']. Commissioned by the Netherlands Transport Research Centre (AVV), the Netherlands Institute of Spatial Research (RPB) and the ministries of Economic Affairs (EZ) and Spatial Planning and the Environment (VROM), this served to provide an initial elaboration of the *Omgevingsverkenner ICT, ruimte en mobiliteit* ['Quick scan of ICT, space and mobility'] produced by the

Effects on spatial claims

The manner in which teleworking will effect spatial claims depends on a number of factors. Firstly, the overall extent of the practice is an important factor. How many people now telework in the Netherlands? Straight away, this is a difficult question to answer, since the literature offers various definitions of 'teleworking' (and 'telecommuting'), resulting in a number of different estimates of the scope. Reisen concluded as much as long ago as 1997. In AVV (2003), the differences are once again set out. The scope of teleworking and the number of teleworkers are both dependent on the definitions applied. Several studies seeking to measure the same thing have nevertheless applied different definitions. Some, for example distinguish between teleworkers and 'supplementary' teleworkers, whereby the duration of the work process is the distinguishing factor. Those in the former group work from home at least one day a week on a regular basis, while the latter do so less frequently. Other studies take the location of the work as their criterion, while yet others consider the nature of the work. Another important factor is the degree to which ICT is used. Based on survey material compiled by CBS/Statistics Netherlands , a telecommuter might be defined as a person who is in a contractual employment relationship (i.e. on the payroll of an employer) and who has used a computer at home, wholly or mostly for the purposes of that employment, on at least one occasion during the past four weeks. Those who use a computer primarily for private purposes, or only engage in work on a sporadic basis, do not fall under this definition and are hence not teleworkers. Those who use the computer at home for work purposes but are not on the payroll of an employer (e.g. freelance staff or those running a home-based business) are similarly excluded.

Despite the limitations of the available data, several studies conclude that the extent of teleworking has increased markedly over the past decade. In its report '*e*WORK 2000', the European Commission reviews the current status, the potential and the altered perceptions with regard to teleworking. It states that teleworking in the EU has grown from a 'few' million people in 1994 to some 6 per cent of the working population in 1999.

A survey conducted by MuConsult (2003) further to prior CBS/Statistics Netherlands studies (and the definition they apply, as stated above) identifies a group of teleworkers

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Netherlands Organization for Scientific Research, Institute for Traffic and Transport, Logistics and Spatial Development (TNO Inro).

who work with a computer at both the office and at home (Type 1) and a group who work solely from home (Type 2). Overall, almost 12 per cent of the working population may be regarded as teleworkers, 3.3 per cent working exclusively at home and 8.5 per cent at one or more other locations as well. The characteristics of the group are also noteworthy. Persons with more than one 'workplace' generally have an above-average income and work 30 hours a week or more. For those who work exclusively at home, the situation is reversed: they have a relatively low income and tend to work part time. This group comprises a number of students and people with a supplementary 'job on the side', e.g. in telemarketing.

Various studies focusing on the availability of teleworking jobs with a view to establishing future potential conclude that the proportion of teleworking positions is still relatively low. In Van Oort *et al.* (2003) various studies are highlighted to state that the potential in the current situation has an upper limit of 30 per cent. It is therefore interesting to note that not all computer-workers (2003: 60 per cent) are actually teleworkers. The practice is particularly suitable for highly standardized administrative work, for which no resources other than a PC are necessary. Nevertheless, even for these activities, which require no direct, localised input from others, employees prefer to have contact with others in the workplace. 'Face-to-face' contact seems to play a fundamental role in economic processes, for which ICT is no substitute. Particularly where complex information transfer ('tacit knowledge') is required, proximity and face-to-face contact remains an important factor and where advanced ICT applications are available, the majority of workers continue to seek personal contact. They wish to spend only a part of their working week in teleworking. In addition, the opportunities offered by the employer play a part. Not every organization which can, in theory, permit teleworking will actually do so. Similarly, not every employee who is able to telecommute will choose to do so in practice.

In terms of spatial claims, the frequency of teleworking is an important factor. The number of days that a person spends working from a location other than the office will influence the total impact of the practice. The idea that great space savings can be made in the office situation when people are working at home is based on the principle that the occupancy of the workplace will sometimes be so low that one and the same desk can be used by several people at different times. When these 'shared workstations' are introduced, the space requirement per employee is, in theory, smaller. Fewer permanent

workstations are needed, and the number of places is no longer equal to the number of staff members, hence the demand for space is reduced.
At present, however, the majority of teleworkers work at home on only one day (or less) per week. The number working at home for two or more days in the week in the course of permanent employment is limited to a 'hard core' of 5 per cent of all home-workers (Breedveld and Van den Broek 2003, based on the definition of 'home-working' stated in the *Tijds Bestedings Onderzoek*). Those with a 'split' workplace tend to telecommute with rather limited frequency. An average of one day in the week for a relatively small group of jobs will not lead to any substantial space savings. Accordingly, it is the aforementioned 3.3 per cent of the working population working exclusively from home who are likely to provide any gains. However, this group comprises mainly part-timers and people who have not previously participated in the economic process. Space savings will therefore be limited.
Another effect on the spatial claims in offices may come about if the function of the office were to change, perhaps becoming more of a 'meeting place' than a workplace. Here too, we see the importance of face-to-face contact, which calls for more conference and meeting areas. A greater amount of space is also likely to be required for consultation and relaxation. These extra functions, and the space they demand, will therefore serve to cancel out (wholly or partly) any space savings achieved through the introduction of shared workstations (Louter 2001; Horan 2000). An excellent example of an office which acts as one large meeting place in the Grand Café tradition, with several relaxation areas available, is that of Interpolis in Tilburg (see Veldhoen 2003).

It is unclear what the overall effect will be in terms of the spatial claim per employee in the original office buildings. Some researchers have great expectations with regard to the influence of ICT; others are more sceptical. The introduction of shared workstations (and even the removal of some workstations from the original office building) may be accompanied by the creation of special teleworking centres (Louter 2001). Such centres, intended for the staff of one specific company, may merely cause a shift in (the distribution of) office space within the organization. In order to determine the overall effect on the demand for office space per employee, this extra space must be added to that which remains in the original office. It is not unlikely that the total space demand will actually increase.

Louter (2001) concludes that the implementation of teleworking and the relevant shared workstations will in any case give rise to a different type of building for office-based activities. However, it will not necessarily lead to any reduction in the total office floorspace required per employee. Indeed, the average (total) floorspace per office worker may be greater, since some staff will use several workstations rather than just one, as in the current situation. Moreover, it is difficult to organize the use of a shared workstation in such a way as to ensure an optimum occupancy rate.

The spatial effects are not confined to offices. It is often stated that, when economic activities are conducted from home, space savings will inevitably be achieved in offices. However, teleworkers require more space in the home. When looking at the overall claim on space required to conduct office activities, that extra space in the home must be taken into account. Again, part of any gains offered by the introduction of shared workstations will be cancelled out. It must therefore be asked whether the emergence of teleworking is likely to increase demand for space in the home setting.
The influence of teleworking on the choice of housing and housing location remains limited (Goetgeluk *et al*., 2002). Teleworkers do not differ from other housing consumers (with a comparable income) in terms of location preferences. Neither does teleworking seem to be a determining factor in the location decision. Nevertheless, compared to other housing consumers, teleworkers generally prefer to have an extra room which can be used as the 'home office'. Research by MuConsult (2003) suggests that not only do teleworkers wish to have this extra room, but that the rest of the house will generally be larger as well. This greater space requirement is largely due to the higher disposable incomes enjoyed by this group. At present, income seems to have a greater effect on housing preferences than ICT in terms of the required environmental quality, floorspace requirement and other location factors (VROM Council 2001). In other words, people's desire to have more spacious surroundings is primarily influenced by income (MuConsult 2003). This does not detract from the fact that there is a demand for space on the part of teleworkers in particular, whether based on income or the nature of the profession in which they engage. We may therefore conclude that, if the teleworking trend continues, today's housing stock will fail to meet future requirements.
A second supposition regarding the effect of teleworking on the housing market is that organizations base their choice of location partly on the local residential climate. The quality of the setting is often regarded as a factor which organizations take into account

in their location decisions. Further to the premise that employees and companies (for whom the availability of knowledge workers is the only location determinant) are 'footloose', the literature suggests that ICT companies will indeed go where the staff are to be found (Florida 2002). This is confirmed by American research conducted by Love and Crompton (1999), who studied companies which had recently made a choice of location and the various location factors that had been considered when doing so. The unquestionable conclusion was that the residential environment is a significant factor, particularly for companies which are extremely 'footloose' (i.e. with few or no ties to any one location) but which require knowledge workers in order to function effectively. This chimes well with the argument that companies in Research & Development and hi-tech activities, and those in knowledge and information-based services with a high proportion of graduate or specialist staff, consider the quality of the residential setting to be important. In general, these are all ICT-sensitive companies. The American study demonstrated that such organizations prefer a business location which is in or close to a residential setting of high quality. However, the situation in the Netherlands is slightly different, as shown by a study of knowledge workers by Van Oort *et al*. (2003). The knowledge workers themselves are primarily concerned with the residential environment above any other factor, such as the availability of work (i.e. easy access to the greatest number of potential jobs). Nevertheless, it is noteworthy that ICT service companies which have recently located have generally known the preferences of their knowledge workers but have not necessarily acted upon them. They do not consider these preferences to be a crucial location factor, even though the knowledge workers themselves are by far their most important production factor. The traditional locations of business sites, together with agglomeration factors, remain the driving force behind these companies' location decisions. ICT service providers seem to take various location factors into account when selecting premises. The most important are the presence of telecommunications infrastructure, the availability of staff and (physical) accessibility.

That difference between the Dutch and American situations may be explained by the fact that a high quality of residential environment requires a green, quieter, suburban location with ready access to the amenities offered by the central urban areas. This complicates the location choice of those American companies who wish to meet the wishes and requirements of their staff. However, the polycentric structure of the Netherlands (or at least the Randstad is) and the willingness of knowledge workers to

commute further than average enables them to live at a greater distance from the work location (they have a higher commuting tolerance).

Spatial differences in teleworking

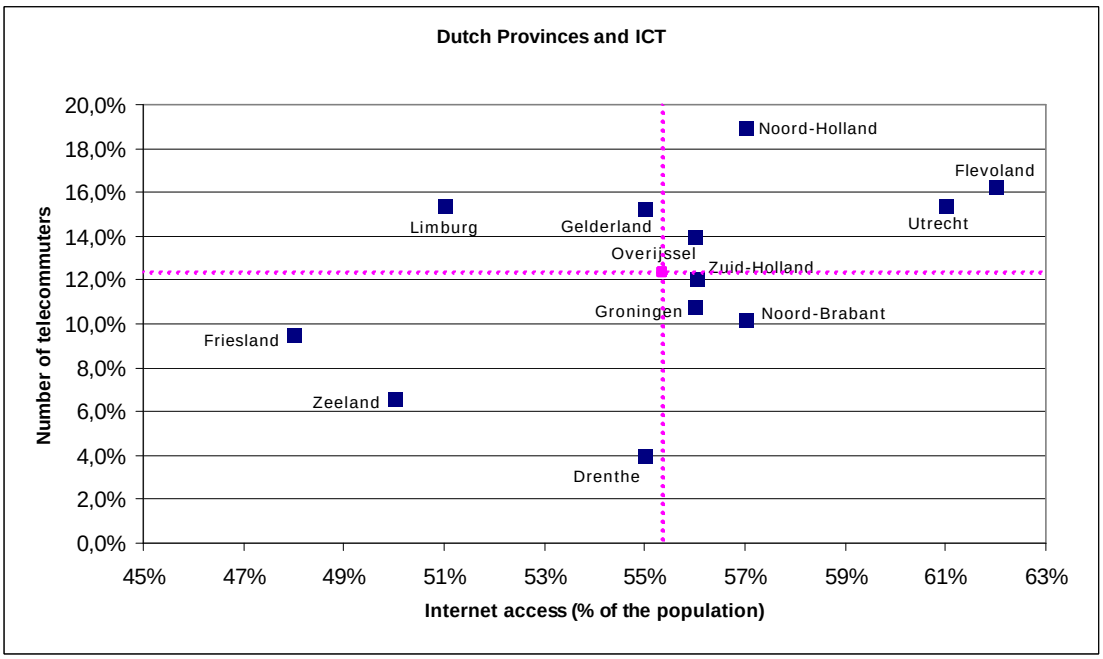
The phenomenon of teleworking is a good example of how workers can adapt their behaviour due to ICT. There are, of course, various prerequisites, such as access to a computer and the Internet, and the willingness of companies to facilitate teleworking. Although the Netherlands' ICT infrastructure offers nationwide coverage, the regions make use of it to different degrees. Internet access in the more peripheral regions is below the national average, while those regions with above average Internet access are more centrally located with respect to the economic concentration area. See Figure 9. Moreover, the Randstad has a higher percentage of companies with teleworkers than the rest of the country. In the major cities of the west in particular, teleworking is relatively well established. Both the number of companies allowing teleworking and the number of staff per company actually doing so are significantly higher in the four major cities than in the rest of the western region. The northern Netherlands (Noord-Nederland) lags behind in this regard (MuConsult 2003).

The MuConsult (2003) study states that the proportion of teleworkers within the Netherlands' total working population is approximately twelve per cent. In the more peripheral provinces, Friesland, Groningen, Drenthe, Zeeland (as well as Noord-Brabant) the proportion is somewhat lower, while that in the centrally located regions such as Noord-Holland, Flevoland and Utrecht is somewhat above average (see Figure 9). This distribution pattern is in itself remarkable. One might expect staff who are given the opportunity to telecommute to locate in the peripheral regions, since they will experience little inconvenience from the greater physical distances to the central economic concentration areas. One might also expect certain areas to have a high number of (teleworking) jobs per square kilometre. However, this is not the case. Clearly, there are other factors which influence the decision whether to telecommute or not. In order to explore these factors in depth, a more comprehensive analysis of data concerning the companies and their teleworkers is required. What are the explanatory factors underlying the spatial differences in teleworking penetration, and are spatial factors themselves a determinant?

When considering different types of residential setting, most teleworkers are to be found in the city centres, although the green, rural village setting also has a relatively high

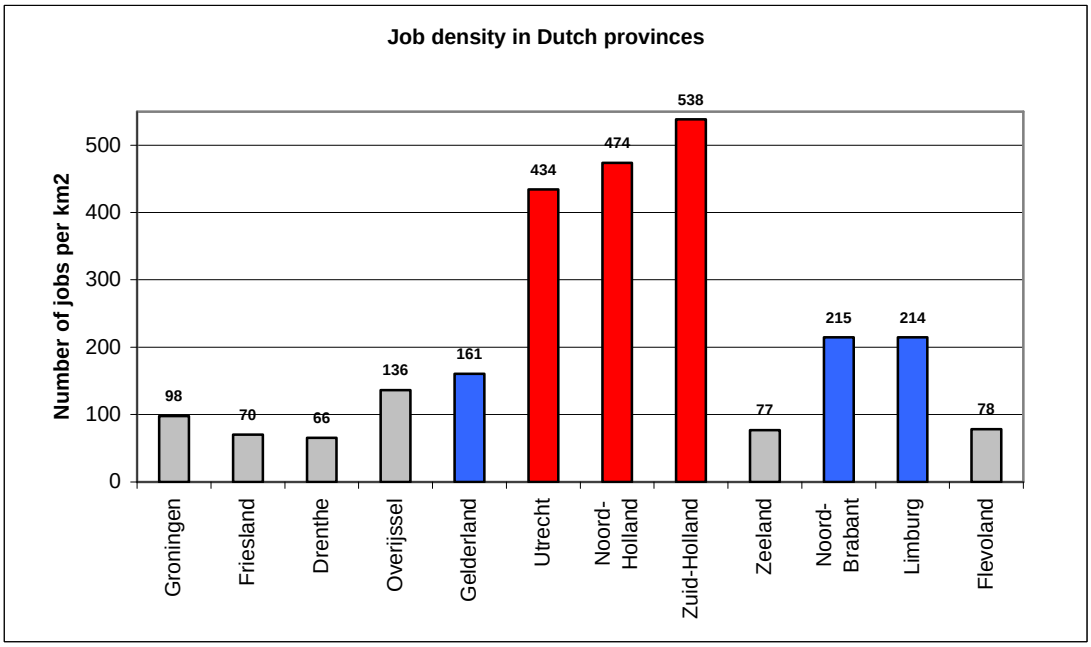
number. In other words, we find teleworkers concentrated in the two residential settings at the extreme ends of the spectrum. This surely calls for further research to understand the reasons for this phenomenon.

Figure 9 Number of teleworkers and Internet access in Dutch Provinces



Source: RPB, based on CBS/Statistics Netherlands 2003 and MuConsult 2003, The national average is indicated by the dotted line.

Figure 10 Number of jobs per square kilometre in Dutch Provinces



Note: **Red**: High Density (>300 jobs per km2), **Blue** Moderate Density (150 –300 jobs per km2), **Grey** Low Density (<150 jobs per km2)

Source: Compiled by the RPB, based on CBS/ Statistics Netherlands Statline report.

SUMMARY AND CONCLUSIONS

ICT has opened new possibilities in all areas of economic and social development. Nevertheless, even twenty years after the information 'revolution' combined with that of communications, it remains unclear whether the development processes in society are very much different to those which could otherwise have been expected. In fact, a substantial body of research suggests that Information and Communications Technology has had relatively little impact in terms of the spatial planning of the working and residential functions. Although there are many apparent changes which are attributable to ICT – working at home rather than in an office, companies located far away from the 'old-fashioned' urban agglomerations - it would not be appropriate to speak of a 'revolution'. Social and societal rigidity and the unwillingness to give up established rights in today's consumer society are still marked. Inertia is strengthened by the deep-seated traditional advantages of existing systems and locations.

Our conclusion is that this rigidity, the resistance to change, is of a more obstinate order and impact than anything seen at the beginning of the other revolutionary waves of economic and technological development. When the automobile first became available to the general population (and in their turn other consumer durables such as the refrigerator, microwave, television, video, CD, DVD, etc.) there was often some considerable resistance. Nonetheless, all such innovations did finally become accepted, and their various applications served to boost economic growth. In many cases, such innovations also had a clear impact on the spatial organization of economic activity.

In the case of ICT, things are slightly different. The things that ICT seeks to replace appear to be irreplaceable to some degree. Companies and individuals can communicate using e-mail, but their most important decisions are still made during face-to-face contact. In fact, the increase in appointments made by e-mail has actually given rise to a greater number of formal or informal meetings between people. Working at home is now possible, but remains confined to the highly standardized administrative work or very specialized personalized work (for example editing, translating and writing) which requires no resources other than a PC. Yet even in this activity, which requires no direct, localized input from others, people still seek contact with their colleagues in the

workplace. The work conducted in a setting other than the home forms an essential component of our modern lifestyle and routine.

We have cited ICT companies as an example of the integration of ICT in business practice. When considering the location requirements of these companies, we learned that the location of ICT starters and the growth of established ICT companies follows and confirms the existing spatial-economic main structure of the Netherlands. Certain regions are responsible for the majority of positive development, and hence remain at the top of the regional league table. In the case of the ICT sector, the northern section of the Randstad is the focus of development, with an extension along the A2 motorway corridor to Eindhoven. Outside the Randstad, the medium-sized cities (Arnhem, Eindhoven, Enschede, Groningen) and their respective regions are the hotspots of the commercial ICT dynamic. Nevertheless, they have less development potential than the cluster in the northern Randstad.
Internationally, we can see a comparable pattern in Belgian Flanders and Germany.[10] Interestingly, it is often the established, heavily urbanized, economic centres which have greatest potential for further growth and innovation, even without the ICT revolution. The relatively peripheral areas, such as Noord-Nederland, Belgian Wallonia or Mecklenburg Vorpommern in Germany, have as yet been unable to benefit from the 'footloose' character of ICT activity, despite having invested in their ICT infrastructure.

This paper also considered possible changes in the location behaviour and preferences of office-based companies further to the emergence of ICT, and the possible effects of teleworking on the amount of office space required. Here too, the current number of teleworkers fails to meet the full potential. There has been no 'revolution' in space usage, in the sense that the requirement for space within the traditional office was expected to decrease. Indeed, teleworking gives rise to the requirement for additional space in the home. Neither has teleworking brought about any fundamental shift in the spatial patterns of economic activities.

[10] Burgeoning concentration in the Flemish Diamond region (Antwerpen-Gent-Brussel) and in the corridor towards Zaventem Airport, a similar development in the Stuttgart-Munchen corridor and the relatively limited development potential of isolated local ICT hotspots such as Lyon in France confirm the validity of our analysis of developments in the Netherlands (see Van Oort *et al* 2003).

Overall, the empirical findings demonstrate that society at the regional level is still rather rigid when it comes to facilitating new technological developments. This does not argue in favour of Toffler and Naisbitt's 'future shocks', nor the more recent theories of Cairncross (2001) and Kotkin (2000), who suggest that unlimited (spatial-economic) possibilities would emerge for, and because of ICT. However, the research discussed in this paper does rely on a number of other terms which appear essential to understanding the relationship between ICT and space: networks, externalities, 'spaces of flows', penetration of computer automation, 'splintering urbanism' and 'dispersed deconcentration'. These are the terms which are truly significant and which must form part of the major structuring elements of future research into the relationship between ICT on the one hand and spatial (urban) development on the other. Because these terms are very recent, there is as yet little available research to confirm or disprove their validity. Nevertheless, Graham and Marvin (2001) offer a large number of practical examples to demonstrate that these concepts are no 'one-day flies', but reflect and describe ongoing developments in the spatial development of urban areas. Moreover, our exhaustive examination of research findings in both Dutch and international literature demonstrates that the spatial order is not merely conforming with past traditions, and that new conceptual frameworks are necessary if the spatial developments are to be characterized effectively, even though the use of ICT is largely restricted at present to improving the efficiency and effectiveness of business processes.

The spatial impact of ICT on the Dutch spatial order becomes evident somewhere between two opposite extremes: the 'existing structure' and 'complete footlooseness'. These concepts are therefore often - wrongly - presented as the only two development paradigms. Spatial and sectoral research at the micro-level reveals that the agglomeration effects are likely to spread over larger urbanized areas of the Netherlands, which will then serve as a 'breeding ground' for ICT companies and for ICT use in business in general, irrespective of sectoral structure. Traditionally, it has been the towns and cities which have formed the chosen location for ICT starter companies and which have presented a setting in which such companies cluster due to agglomeration advantages. Today, it is the urban region, with its multi-nodal pattern of economic centres, which performs this function. In the traditional urban centres, suburban areas and even relatively rural areas (provided they enjoy reasonable accessibility) between the agglomerations, the same agglomeration advantages are to be

seen, with far fewer agglomeration disadvantages. All types of location fulfil a function in the urban ‘patchwork quilt’ of economic development. Although the processes of suburbanization and polycentricity have been established in the Netherlands for some time, most studies to date show that ICT is playing a facilitatory role in it. It may also be remarked that, compared to developments in other western countries (notably the United States), the role of the ‘traditional’ urban centres has not been devalued to that of some ghetto-like desert. Even - or especially - in the ICT era, the city centre functions as a meeting place, a shopping centre and an entertainment venue for companies and households. Urban fragmentation is therefore not only directed outwards, but the centres themselves continue to fill essential functions.

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