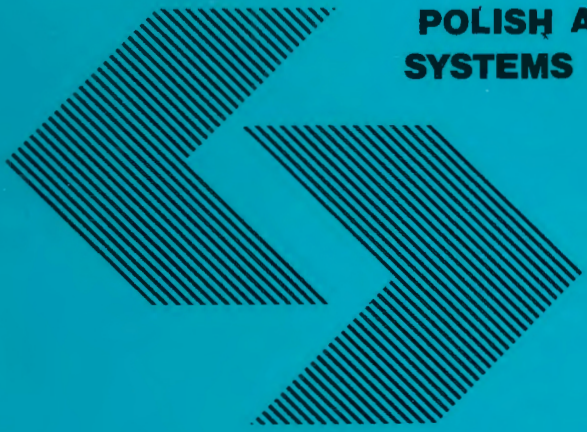
POLISH ACADEMY OF SCIENCES
SYSTEMS RESEARCH INSTITUTE



STRATEGIC REGIONAL POLICY

A. STRASZAK AND J.W. OWSIŃSKI
EDITORS

PART I

WARSAW 1985

SYSTEMS RESEARCH INSTITUTE
POLISH ACADEMY OF SCIENCES

STRATEGIC REGIONAL POLICY

Paradigms,Methods, Issues and Case Studies

A. Straszak and J.W. Owsiński
editors

Documentation of the workshop on "Strategic Regional Policy", December 10 - 14, 1984, Warsaw, organized by the Systems Research Institute, Polish Academy of Sciences and the International Institute for Applied Systems Analysis

PART I

Warsaw 1985

III. TECHNOLOGICAL AND SCIENTIFIC ISSUES

KNOWLEDGE CENTRES AS STRATEGIC TOOLS IN REGIONAL POLICY

Arnoud Mouwen and Peter Nijkamp
Free University of Amsterdam

1. INTRODUCTION

In recent years, much attention has been focused on the long-term pattern of structural changes and economic fluctuations (Kondratieff cycles, e.g.), at both the national and the regional or urban level. Various publications demonstrate that (lack of) innovation is regarded as one of the driving forces behind the mechanism of economic growth and decline. This implies that the economic perspective of a city or region is dependent on the innovative activities within the area concerned. On the other hand, the presence of a highly-qualified production environment in a city or region may favour the development potential of the area concerned through its 'incubator' function (the so-called breeding place hypothesis).

It should be added, however, that empirical research in the USA (see Malecki, 1979) has demonstrated that many large cities - especially the big metropolises - have lost their innovation potential with respect to large-scale firms, while medium-sized towns exhibit a boom process due to the design and use of new technologies. Consequently, spatial dynamics and innovation are closely interwoven phenomena.

A key element in innovative efforts is creativity. Creativity is the ability to generate and to structure information in such a way that it favours a synergistic process of knowledge and skill in order to create a surplus value of insights (higher-order knowledge). Stress and structural instability are some of the driving forces for creativity (the so-called 'depression-trigger hypothesis'). Such a creativity requires a high level of skill and education, a diversity of disciplines, a wide variety of internal and external communication channels, and a discrepancy between available means and socio-economic needs.

In light of the important role of creativity in stimulating innovation and hence regional development, it is no surprise that many regions have adopted a strategy of establishing so-called knowledge centres in order to favour the innovation and growth potential of the region concerned. The present paper will provide a critical review of this knowledge centre concept by examining its theoretical foundations, its potential as a strategic regional policy tool, and its practical use in various countries. In the second part of the paper some empirical evidence regarding the Dutch geographical distribution of knowledge centres and the regional innovation potential will be provided, followed by some policy conclusions.

2. KNOWLEDGE CENTRES

Knowledge centres make up part of the R & D infrastructure of a country or region. They may be defined as a spatial concentration of scientific and technological communication, information and research centres for both the public and private sector (inter alia science parks, innovation poles, transfer centres and information poles). Consequently, in as far as innovation policies are focussed on an improvement or enhancement of R & D efforts (in both the private and the public sector), the creation of knowledge centres is of utmost importance.

The geographical location of knowledge centres has in recent years be come an issue of important scientific research. It is often taken for granted that technological innovations - especially product innovations - are strongly favoured by an urban production environment (see, for instance, Ewers and Kleine, 1983). Large cities and metropolitan areas appear to provide a favourable breeding place due to scale and agglomeration economies in such areas. It is conceivable therefore that innovation policies are often oriented toward an improvement of the 'incubator' function of urban areas. In this respect, there is a strong parallel between current innovation policies and former growth pole policies, which also took for granted the existence of centrifugal growth impulses.

It is worth noting that various very large cities are loosing their contribution to the regional innovation potential and to the restructuring of the industrial sector in favour of medium-sized cities (see, among others, Cross, 1981; Segal, 1983; and Wever, 1984). Therefore the question arises whether large or medium-sized towns are promising locations for knowledge centres which serve to provide the necessary R & D infrastructure for technological change in a certain area.

The latter question can only be answered if more insight is available into the geographical orientation of innovative firms with respect to external R & D facilities (including knowledge centres). In the context of our paper we will limit ourselves to the industrial sector. Within the industrial sector especially the high technology firms appear to exhibit a high degree of innovativeness and production growth (see also Moore, 1983; and Premus, 1982). Following Doody and Munzer (1981) we define the high technology

sector as a cluster of firms which show a high growth rate, a high amount of R & D expenditures, a high value added, a strong export orientation, and a labour-intensive production technology (especially as far as high-skilled labour is concerned).

The question regarding the geographical location of knowledge centres is closely aligned to the economic and technological function in a large spatial system: Knowledge centres serve to induce, to encapsulate and to transfer innovations. In the first-generating-phase of innovations, a spatial concentration and an orientation toward urban centres may favour innovations, as intensity of information and communication is a necessary condition for innovation potential. In the second phase, where inventions have to be operationalized as feasible and viable innovations warranting a commercial production of new commodities or a commercial introduction of new (production or management) processes, more emphasis is being placed on internal entrepreneurial adjustment processes. In the last phase, however, the position in a communication network is of crucial importance. Whether this desired position leads to a concentration in large cities of in medium-sized cities depends on a trade-off of agglomeration economies versus scale diseconomies (congestion, e.g.). Especially the modern information and communication technology has shaped the conditions for an urban sprawl of innovative firms outside the traditional metropolitan areas (see also Brotchie et al., 1984). In this framework, diffusion and adaption of innovations is very much determining the locational orientation of innovative activities (see Brown, 1981; and Hägerstrand, 1967).

In conclusion, the locational pattern of knowledge centres deserves a careful analysis. There is a priori no guarantee that innovative firms are mainly oriented toward knowledge centres in their close vicinity. It is now of course an interesting research question whether the desired geographical pattern of R & D facilities - seen from the viewpoint of innovative entrepreneurs - corresponds to the actual spatial dispersion of knowledge centres.

3. KNOWLEDGE CENTRES AND REGIONAL DEVELOPMENT

In this section the impact of knowledge centres upon regional development will be discussed in more detail. Particular attention will be paid to the question whether the availability of a high-skilled labour pool exerts a positive influence upon locational decisions of firms in the high technology sector. The results of some noteworthy studies in this context will be presented.

Premus (1982) analyzed the locational factors of high-tech firms in the US. He arrived at the conclusion that the quality and availability of labour, the wage level, and local taxes (insofar as they influenced the propensity to migrate of technical scientific personnel) were major determining factors for locational decisions of high-tech firms. Due to a shortage of technicians, scientists and engineers on some regional labour markets, various high-tech firms appeared to attach a very high priority to the costs and availability of human capital. In this respect, universities played a major role as knowledge centres for the high-tech industry. Surprisingly enough, traditional locational factors (such as transportation and energy costs) appeared to play only a minor role in locational decisions of high-tech firms. It is clear that a joint orientation of high-tech firms toward a scientific and research environment implies a concentration of such firms in regions with a favourable R & D infrastructure (including knowledge centres).

Malecki (1981) came also to the conclusion that the regional availability of a highly qualified labour force is an important factor in the locational choice of an R & D division of a multi-plant organisation. As this labour force attaches a high priority to urban amenities (cultural, social, educational and scientific facilities), the urban environment provides a favourable breeding place for skilled labour. Consequently, there is a strong tendency of R & D activities to locate in urban areas.

Cross (1981) studied the location factors of new high-tech industries in Scotland by means of micro-economic choice analysis. He identified the following determinants: the location of the starting entrepreneur, the location of the former employer, the location where the new entrepreneur was educated, the location of the most important sales market, and the local environment as a whole. Especially the local environment and the

historically grown geographical orientation (inter alia, place or residence or education) appeared to provide a statistically significant explanation.

Cnossen and Koerhuis (1982) made an attempt at identifying the locational factors of computer and soft ware firms in the Netherlands. It turned out - on the basis of detailed questionnaires - that these high-tech firms attached much importance to the accessibility via the transportation network and the availability of parking space, due to the high knowledge intensity and communication orientation of these entreprises. Given the geographical scale of the Netherlands, no specific regional or local sales orientation could be identified. Furthermore, these firms regarded also the availability of knowledge potential of universities, the size of available industrial areas, and the presence of firms in the same sector as highly important and risk-reducing locational conditions. Finally, given the required high skill of most employees in this sector, also a pleasant residential climate and the presence of well-trained personnel received a high priority.

The conclusion from the above-mentioned studies is that the availability of knowledge centres (especially research divisions of universities) is a locational determinant of major significance for the high-tech industry in many countries. In a recent OECD report it is also concluded that the presence of universities in a region is of crucial importance for the socio-economic development of the region concerned, as universities create a production environment that stimulates the high-tech industry through its high-skilled labour force, through its potential attraction force exerted on skilled labour from other areas, and through its indirect facilities (libraries, e.g.)(see OECD, 1984).

Furthermore, universities also have spin-off effects in terms of the creation of highly-qualified production activities directly or indirectly associated with and induced by the universities concerned (see also Cross, 1981; and De Jong, 1983). A good example of such spin-off effects can be found in the Greater Boston area, where the establishment of commercial innovative firms is often generated by academic research. In this respect, the incubator function of a metropolitan area is very much favoured by the presence of highly-qualified academic research institutes.

In conclusion, a successful knowledge centre strategy as part of a regional development policy with respect to innovative firms requires the fullfilment of the following conditions (cf. De Jong, 1983):

- presence of research institutes that may act as breeding places
- presence of a high-skilled labour force
- public support for R & D activities of starting innovative firms
- availability of venture capital
- presence of a stimulating and innovative entrepreneurial climate
- availability of inexpensive terrains for new innovative entrepreneurs.

The above-mentioned analyses suggest that large metropolitan areas are providing the most favourable breeding place for innovations, but this is not always true. Premus (1982), for example, observes that the Sunbelt areas in the USA are exhibiting bottleneck factors (such as high-labour costs, high-land rents, lack of industrial space, high-local taxes and traffic congestion), so that there is a tendency among new high-tech firms to move away from the Sunbelt states to the Mid-West. Cross (1981) also shows that places around bigger cities and smaller industrial areas attract more high-tech firms than cities themselves. Similarly, Wever (1984) finds for the Netherlands a similar pattern: the net number of new firms in the ring of intermediate areas around the (industrialized) Dutch Randstad (the 'Rimcity') is higher than in the Randstad itself (and also higher than in the peripheral areas). A similar observation was made by Hoogteijling (1984), who observed that the number of innovations in the Dutch industry scored much higher outside the Randstad, and by Cnossen and Koerhuis (1982), who found that computer and software firms had a strong preference for a location in the intermediate zone around the Randstad.

The increased orientation of innovative new firms toward accessible areas outside large agglomerations may mainly be due to congestion effects. It is worth noting, however, that the migration of an existing firm may - in addition to bottleneck factors - also be explained from its phase and position in a product cycle. This will briefly be discussed at the end of this section.

During the design stage of a new product an intensive communication with R & D institutes (including knowledge centres and universities) is necessary,

leading to a geographical concentration of innovative activities in urban areas; such a location is often risk-reducing and cost-saving, witness also the success of science parks and innovation poles.
As soon as the production of new commodities has to be implemented, however, other locational factors (market orientation, e.g.) may become important, so that in this phase of product development the firm may be willing to move to more peripheral regions offering a cheaper location. Thus the locations of new-product firms are co-determined by their product cycle.

It should finally be added, however, that often the R & D divisions of such firms and firms specialized in high-tech design are found in (the vicinity of) an urban environment due to the favourable innovation potential in such areas (see Premus, 1982).

4. KNOWLEDGE CENTRES: A COMPARATIVE ANALYSIS

The concept of knowledge centres is marked by a wide variety of appearances among different countries, such as science parks, innovation poles or transfer centres. In the framework of a concise exploratory comparative analysis, some experiences from the USA, Great Britain, FRG , Sweden and Canada will briefly be described.

A. USA

The idea of knowledge centres has already a long history in the USA, where already in 1951 the Stanford Industrial Park was established in Palo Alto (based inter alia on military defense and R & D contracts). Three successful examples of the knowledge centre concept will be described here, followed by a brief survey of alternative knowledge transfer concepts.

(a) The Silicon Valley as an offspring of the Stanford Industrial Park is the classical example of an integrated rapidly growing knowledge centre based inter alia on the advanced computer and telecommunication technology. Its commercial basis, its position as the nucleus of a communication network and its efficient organizational structure shaped the conditions for a successful regional development pole.

(b) Route 128 in the Greater Boston area has many elements in common with Silicon Valley. The rapid development of this area induced by military and aircraft R & D expenditures and later on by many high-tech firms, is a clear spin-off effect of the Boston-Cambridge scientific climate. Its continued success was mainly due to the innovation potential in this area which was caused by its favourable sectoral structure, its diversified labour market and its efficient institutional structure.

(c) The Research Triangle Park North Carolina may be regarded as a spin-off result of the universities of Raleigh, Durham and Chapel Hill. It started as a purely academic research park, but later on it encompassed also new production activities. Nowadays it contains many R & D divisions of private enterprises (IBM, e.g.), while it continues to attract high-skilled labour. The presence of academic research institutes and the favourable social climate were mainly responsible for the success of this knowledge centre.

In addition to these glaring examples of knowledge centres also various alternative initiatives in the USA may be mentioned:

- University-Industry Cooperative Research Centres (stimulated by the federal government), which serve to stimulate cooperation between academic research institutes with a specific know-how and the industry.
- Small Business Innovation Programmes (supported by the National Science Foundation), which aim at stimulating a commercial operational development of innovative ideas.
- Innovation Centres (supported by the federal government and based on a cooperation between private industry and universities), which serve as a training institute for entrepreneurs, as a breeding place for innovations and as a consultancy centre for innovative inventors.
- Small Business Development Centres (supported by local governments), which aim at providing coordinated assistance to the retail sector and small-scale industries.
- University Industrial Associates (stimulated by the university), which serve to establish a closer formal link between entrepreneurs and universities, so that also the accessibility of research divisions of universities with respect to private industries is improved.
- Venture Capital Funds (supported by universities), which serve to stimulate the application of academic knowledge in private industries, so that the risk of introducing new production techniques may be diminished.

B. Great Britain

In Great Britain much emphasis has been placed in recent years on the design of science parks. In various cases, however, the integration of science parks with the regional or local institutional structure has been overlooked, so that the success of such knowledge centres has not always been overwhelming. A good example however is the Cambridge Science Park which will first be discussed, followed by a survey of alternative forms of knowledge transfer between universities and industries.

The Cambridge Science Park is characterized by the following favourable location factors: extensive space for innovative industries, favourable living conditions, potential accessibility to scientific research institutes, and availability of good entrepreneurial facilities. Surprisingly enough however, this science park does not have more intensive relationships with Cambridge University than R & D firms outside this park. Therefore, it may

be concluded that not the science park itself, but the whole Cambridge area provides a breeding place for innovative firms (see also Moore and Spires, 1983; and Segal, 1983). Thus the Cambridge area as such fullfils an incubator function characterized by: various highly-qualified social and cultural facilities, the presence of prestigious private and public research institutes and of the university, a diversified production structure, the availability of skilled labour, a stimulating attitude of the university with respect to new business activities and entrepreneurship, a support of banks in stimulating new entrepreneurs, an initiating role of the local government in providing the necessary physical infrastructure, and the (negative) pressure exerted by budget cuts on young inventors to start their own innovative activities. It should be added, however, that according to Moore and Spires (1983) it is doubtful whether the employment effects of this science park are more favourable than in any other alternative industrial development project.

Beside the science park development discussed above (and beside similar) developments taking place in the London-Reading-Bristol corridor), also alternative initiatives with respect to small-scale business firms are taking place in the U.K. Examples are:

- Industrial Research Groups, which serve to combine and transfer expertise in the area of technology and entrepreneurial design.
- New Enterprise Workshops, which aim at making available university facilities to entrepreneurs.
- Industrial Science Parks, which provide facilities for an industrial high-tech complex near a university.
- University Companies, which serve to stimulate industrial activities within universities by means of government subsidies.
- The National Research Development Corporation, which aims at transferring new ideas from public institutions to the commercial business sector.
- Wolfson Industrial Units, which focuses on applied technological contract research by small-scale R & D centres in universities.

c. FRG

In FRG also various activities in the area of knowledge centre policy are taking place. The most promising example is the Kernforschungszentrum (Core Research Centre) in Karlsruhe. This is a national research institute which aims to develop new technological solutions for large-scale, complex

and interdisciplinary problems requiring a large amount of finances, a high-skilled labour force and a need for long-term planning.

In addition, a system of advisory transfer centres for small-scale business activities has been established (so-called Beratungsstellen), as well as an information transfer centre (in Bochum) in order to provide up-to-date insight into new developments in the information technology.

D. Sweden

Knowledge centre concepts in Sweden are mainly materialized in so-called university transfer bureaus, which serve to stimulate the application of new technological inventions in the business sector. Ways to arrive at this goal are: the distribution of professional information, the design of cooperation projects between researchers and firms, an increase of the accessibility to university facilities, the introduction of joint R & D projects, etc.

E. Canada

Canada is also establishing various knowledge centres around universities (in Waterloo, e.g.). Other initiatives are:

- the contracting out' principle, which means that federal departments have to spend R & D money in private enterprises;
- the Industrial Research Assistance Program, which serves to cover the salaries of industrial researchers;
- the cooperation projects of the National Research Council with respect to the industry.

In conclusion, there is a wide variety of appearances and impacts of knowledge centres on regional industrial innovation. In the USA universities appear to provide a fairly direct incubator function for the high-tech, whereas in Europe universities appear to provide a more general academic research climate for innovations. Clearly, it should be kept in mind that the geographical scale of European countries is drastically differing from that in the USA.

In the second place, it is worth noting that a successful knowledge centre also requires a suitable organizational, institutional and physical infrastructure in order to guarantee a fruitful cooperation between industry and academic research institutes.

Thirdly, it has to be observed that in almost all cases a successful knowledge centre was accompanied by a favourable development of the region at hand. Though cause-effect relationships are difficult to disentangle in this context, it is plausible that a fruitful regional or urban breeding place encompasses also additional elements like educational facilities, skilled labour, venture capital, high-tech infrastructure, and appropriate public policies. In this respect, a knowledge centre is only one of the desirable conditions for innovative regional development efforts.

It has to be added that - despite the limited role of universities as direct knowledge transfer centres - that universities may provide teaching programmes focusing on the high-tech industry, so that by means of appropriate investments in human capital the high-tech sector can be stimulated in an indirect manner.

Besides, many new innovative firms appear to be more technology-driven than market-oriented, so that university initiatives focusing on technical, financial, marketing and organizational support are an extremely important complement to R & D efforts.

Finally, many small-scale innovative activities appear to be generated in the urban area, especially in older urban districts or in renewal areas. Such a breeding place function of cities deserves full-scale attention of a knowledge centre policy (for instance, by providing more venture capital for new small-scale industries).

In this part of the paper a case study will be described that deals with the spatial dispersion of knowledge centres (chapter 5), the spatial dispersion of R & D and innovation (chapter 6) and with the confrontation of these two dispersion patterns.

5. THE SPATIAL DISPERSION OF KNOWLEDGE CENTRES: A CASE STUDY FOR THE NETHERLANDS

Knowledge and information are necessary ingredients for innovation. As a consequence, the spatial dispersion of knowledge is linked to that of innovation. If a direct link would exist between the knowledge potential in a region and the innovation activity in that same region, it would be possible for the government to use the location of knowledge centres as a strategic tool in regional policy. By influencing the location of the public knowledge centres - which make up an important part of the total knowledge potential - the government is able to reinforce the local and regional development potential in lagging regions.

It is therefore interesting to investigate the regional relationship between knowledge centres and innovation activity. In this study on the Netherlands the following categories of institutes and organisations are regarded as part of the Dutch knowledge centre infrastructure:

- departments of universities and institutes of technology as far as they are involved in R & D;
- research institutes which are government owned;
- research institutes which are for more than 50 percent subsidized by the government;
- the R & D departments of the privately owned industry.

For practical reasons it was decided to restrict the study in some respects; special consideration is given to:

- knowledge transfer to the industry; this implies that only those knowledge centres which provide knowledge transfer to the industry are taken into consideration (especially centres that provide technical scientific knowledge);
- R & D divisions of the five biggest Dutch multinationals in private sector. Recently the outcomes of an indepth analysis showed that more than 70 percent of the private R & D is concentrated in these five companies;

- the output of the knowledge centres; this is indirectly measured by taking into account the number of R & D employees working in R & D sections or supporting R & D divisions as an indispensable part.

The existing regional classifications of the Netherlands were not very satisfactory from the viewpoint of spatial dispersion of knowledge centres. Therefore a new classification that combines the strong points of the homogeneous and of the modal classification criterion has been developed. In the Netherlands the regional structure is highly dominated by urban agglomerations, so that (socio-)economic processes are often influenced by agglomeration economies. Therefore, the regional classification used in this study is based upon these agglomeration economies and takes into account the important role of inter-urban influences. Besides, such a classification is extremely suited for describing the process of innovation diffusion, which forms an important part of the sequel of this chapter. Various types of agglomeration regions have been distinguished. These agglomeration regions are composed by villages and towns in a certain area which are oriented towards a large city (or set of cities). This orientation is measured by means of an agglomeration index number (ranging from 1 to 9). This index number is computed by analyzing:
- the size and neighbourhood of other cities;
- the quality of the communication network;
- the relative importance of the biggest metropolises.
Figure 1 gives a visual representation of the results.
In the following we will refer to the regions numbers which are based on this figure.

After these necessary introductory comments, we will now take a look at the actual dispersion of knowledge centres. As can be seen in Table 1 the knowledge centres of the universities and the technological institutes are primarily concentrated in regions 1 and 2. This is not surprising because these regions cover a great part of the so-called 'Rimcity', the traditionally highly urbanized core region of the Netherlands where the four main cities are situated.

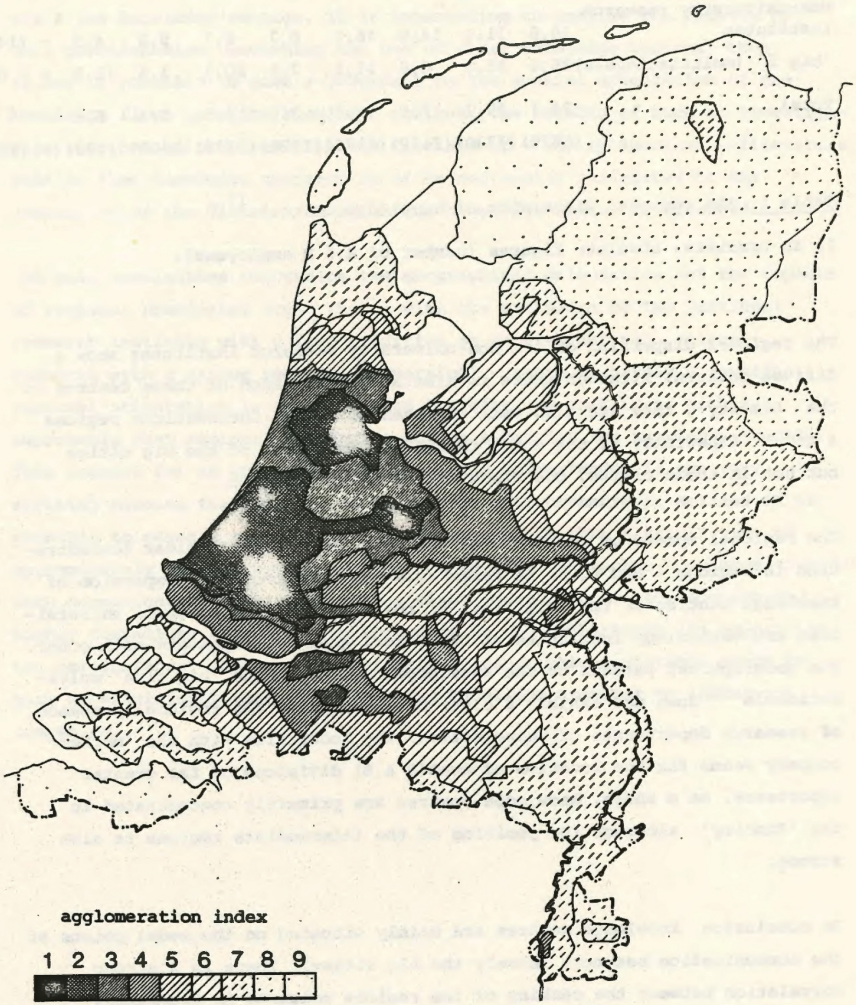


Figure 1. Agglomeration indices for the Netherlands.

knowledge centres (%) \ regions	1	2	3	4	5	6	7	8	9	Tot.
Universities and technology institutes	35,8	27,7	-	15,9	6,4	-	14,2	-	-	(5636)
Non-university research institutes	16,6	31,1	14,8	16,1	0,7	6,7	9,2	4,9	-	(14076)
'big 5' (multinationals)	28,6	15,8	0,6	11,1	7,6	20,1	3,4	12,8	-	(8847)
Total	24,1	25,7	7,5	14,5	3,9	9,5	8,4	6,4	-	
	(6879)	(7330)	(2132)	(4145)	(1124)	(2724)	(2402)	(1823)	(-)	(28559)

Table 1. The regional dispersion of knowledge centres.[1)]

1) In brackets: absolute figures (number of R & D employees).

The regional dispersion of the non-university research institutes show a diffuse pattern. Although there is also a concentration of these centres in the 'Rimcity', they are also well represented in the intermediate regions 4 and 7. Especially in the zones in the neighbourhood of the big cities but not in these cities, one finds this kind of research.

The regional spread of the R & D of the 'big five' shows a clear concentration in regions 1 and 6. It is remarkable that the regional dispersion of knowledge centres of the 'big five' at the one hand, and those of universities and technology institutes at the other, seem to compensate each other. The geographical pattern of the knowledge centres of the 'big five' multinationals does not exhibit a clear orientation to the regional presence of research departments of universities. The local ties with the 'mother' company seems for the location of most(R & D) divisions of far greater importance. As a whole, knowledge centres are primarily concentrated in the 'Rimcity', although the position of the intermediate regions is also strong.

In conclusion, knowledge centres are mainly situated on the modal points of the communication networks (namely the big cities). There is a strong correlation between the ranking of the regions measured in decreasing agglomeration economies and the decreasing presence of knowledge centres. (Kendall's concordance coefficient for these two variables is 0,94!).

With the aid of a questionnaire among industrial entrepreneurs it was possible to measure the use of certain government instruments aimed at stimulating technological innovation.[1] Among these instruments there are a few knowledge centres. It is interesting to analyze the results of this questionnaire concerning the use of these knowledge centres; then it may be possible to give a judgement on the spatial orientation of the knowledge flows from the knowledge centres. The results of such an investigation can then be compared with the findings of - mostly American - literature, stating that knowledge transfer is often regionally restricted to the boundaries of the district in which the knowledge centre is situated.

The main conclusions concerning the geographical orientation and the impacts of regional boundaries are, that - with the exclusion of TNO (national research institute with a long tradition on applied natural science research with a strong regional dispersion) - there is hardly a specific regional orientation in the knowledge transfer, so that it is highly improbable that regional boundaries act as a barrier for knowledge transfer. This outcome for an urbanized country as the Netherlands, is not very striking because for most of the industrial entrepreneurs in Holland it is possible to reach a specialized knowledge centre within a travel time of approximately two hours. Compared to the benefits of such a knowledge transfer, such communication costs have only a minor impact. Due to the compact and highly formalized communication structure in the Netherlands (in opposition to, for instance, the American situation), geographical distance seems to play no significant role in restricting knowledge transfer to industrial companies.

---

1) Credits to Alfred Kleinknecht.

6. KNOWLEDGE CENTRES AND INNOVATION

Knowledge and information are necessary ingredients for R & D and innovation (see for instance Pred, 1977 and Hägerstrand, 1967). The pattern of the spatial dispersion of knowledge could therefore well be related to the spatial dispersion of R & D and innovation.
Also on the basis of the forementioned questioning concerning the innovation behaviour of a representative selection of Dutch industrial companies, this chapter will investigate the regional spread of innovation activities and confrontate that pattern with the regional spread of knowledge centres. Two indicators are used as a measuring rod for technological innovation, namely R & D (percentage of companies per region) and innovation (number of realized innovations per company per region). In our view, the R & D indicators are more clearly interpretable and therefore more reliable than innovation indicators.

As can be seen in Table 2, only a few companies have exclusively external R & D. Because of the small cell frequenties, conclusions concerning external R & D can only be drawn cautiously. Nonetheless, it is remarkable that regions 4 and 7 show relatively many companies that spent all of their R & D capital on external contract research. As a whole the R & D pattern shows that the entrepreneurs in region 1 seem not so innovative as should be expected on the basis of their location in the big cities where the innovative climate is usually assumed to be favourable. In all R & D categories region 1 scores below the average; this results in the highest percentage of companies that have no R & D at all. This means that the core regions are passing through the innovation impetuousness to the intermediate regions 4 and 7, a process that can be observed in many industrialized western countries.

region / indicator	1	2	3	4	5	6	7	8	9
companies with excl. internal R & D	35,9	37,0	33,0	33,1	44,1	36,6	34,8	37,9	45,9
companies with excl. external R & D	3,9	2,2	1,0	4,3	2,9	1,8	6,2	3,1	1,6
companies with both int. and ext. R & D	24,8	30,4	31,5	33,9	22,8	28,2	33,5	27,1	26,2
companies without R & D	35,3	30,4	34,5	28,8	30,1	33,5	25,6	31,9	26,2

Table 2. R & D indicators

If we compare this pattern of the regional dispersion of R & D (Table 2) with that of the regional dispersion of knowledge centres (Table 1), it appears that there is only little or no resemblance between the two patterns. This qualitative conclusion can be made more explicit by using Kendall's concordance coefficient through which it is possible to determine the correlation between these two variables. Kendall's coefficient showed that there is no - and even a slight negative - relation between knowledge centres and R & D per region (c.c. $\tilde{=}$ 0,48).

Concerning external R & D, the quantitative analyses showed a slightly positive coefficient (c.c. $\tilde{=}$ 0,70), which can be seen as an indication that the few companies per region that use exclusively external R & D have a small regional preference for using the knowledge centres which are situated in their 'own' region.

Because the above-mentioned results seem not totally unambiguous, the analysis has been repeated with a R & D indicator that is corrected for the size of the companies per region. Among others Malecki (1980) showed that, on average, big companies invest more in R & D than small companies do. Because the core regions possess relatively bigger companies than the peripherial regions, it is possible that the uncorrected R & D indicators show a bias. Corrected for this bias in company size, the results show a clear indication that there exists no positive relation between the regional dispersion of knowledge centres and that of companies who invest in R & D.

Relying on the assumption that knowledge is necessary for R & D, the conclusion just reached implies that:

- either the entrepreneurs use knowledge which they get from knowledge centres situated in other regions than their company's area;
- or that the entrepreneurs conceive the knowledge from the knowledge centres as unsuitable for their needs, so that they are forced to get the desired knowledge from other knowledge sources.

Although - as has been said - innovation indicators are not as strong an indicator as R & D figures. An analysis of innovation indicators may strengthen the tentative conclusions reached above.

A reasonable innovation indicator that is corrected for the size of the company is the number of innovations (process or product) that is realized per employee per region. As becomes clear from Table 3, the companies in region 4 realize a number of product innovations that is far above the sample mean. On the other hand, the entrepreneurs in regions 1 and 2 are not as innovative as could be expected. (A similar result was reached by analyzing the R & D data). As far as process innovation data are concerned, the pattern is far less clear. The values of that variable per region fluctuate all more or less around the sample mean.

The same distinction between product and process innovations holds true, if the relationship with the regional dispersion of knowledge centres is analyzed. The resulting concordance coefficients for product innovations are all approx. 0,5, which implies that the variables 'knowledge centres' and 'product innovations' show no regional correlation. The outcome for process innovations is far less clear because the calculated coefficients vary considerably.

region / indicators (%)	1	2	3	4	5	6	7	8	9	tot.
realized product innovations/ employee	5,10	3,55	4,90	8,39	3,57	3,81	4,73	3,86	5,31	4,80
realized process innovations/ employee	3,04	2,29	2,45	3,20	4,09	3,28	3,27	3,15	2,72	3,05

Table 3. Innovation indicators.

7. CONCLUSIONS FROM THE DUTCH CASE STUDY

In the previous sections which describe the results of a case study for the Netherlands, it has been shown that - with respect to the regional dispersion of knowledge centres - there is a tendency for knowledge centres to concentrate in regions 1, 2 and 3 (the so-called 'Rimcity'). Despite this result, it should be noted that knowledge centres are also dominant in the intermediate regions (e.g., regions 4 and 7).

The main conclusion which has been reached by analyzing the regional dispersion of innovative activity in the Netherlands (measured in R & D as well as in innovations) is that particularly region of type 1 is not so innovative as could be expected. This result can be seen as a first indication that regional boundaries form no barrier to knowledge transfer. This tentative conclusion concerning the regional direction of the knowledge flows was further elaborated by investigating the spread of innovation activity. Both R & D and innovation indicators showed a regional pattern that showed no relation with that of the dispersion of knowledge centres. The observed variations in the presence of knowledge centres per region can therefore form no explanation for the remarkably big regional differences in innovation activity.

Probably due to the compact and highly structured communication infrastructure in the Netherlands, a policy aimed at reinforcing the regional potential of lagging regions by creating new knowledge transfer centres in these regions, is likely to have no substantial impact. Such a policy does not affect the innovative impetuousness of the entrepreneurs located in these regions. A second and related policy issue is that there seems to be a tendency of the innovative potential in big cities to decline (notwithstanding the fact that the knowledge centre potential in the big cities is enormous). If big cities have to act as a breeding place for new activity, this decline should somehow be stopped. It is shown that reinforcing the knowledge infrastructure in these cities is apparently not a good policy to stop this process of a declining innovation potential in bigger cities.

REFERENCES

Brown, L.A., Innovation Diffusion, A New Perspective, Methuen, London/New York, 1981.

Cnossen, W., H. Koerhuis, De Software- en computerservicebedrijven, een onderzoek naar de structuur en ruimtelijke spreiding van de software- en computerservicebedrijven in Nederland medio 1981, Geografisch Instituut Rijksuniversiteit Groningen, 1982.

Cross, M., New firm formation and regional development, Gower, Farnborough, 1981.

Doody, F.J., Munser, H.B., High Technology Employment in Massachusetts and Selected States, Massachusetts Division of Employment Security, Boston, 1981, p. 2.

Evers, H.J., R.W. Wettman, Innovation-oriented regional policy, Regional Studies, vol. 14, 1980, pp. 161-179.

Hägerstrand, T., Innovation Diffusion as a Spatial Process, University of Chicago Press, Chicago, 1967.

Hoogteijling, E.M.J., Innovatie en Arbeidsmarkt, Economisch en Sociaal Instituut, Vrije Universiteit, Amsterdam, 1984.

Jong, M. de, Regionale condities voor nieuwe hoogwaardige bedrijvigheid, industriële vernieuwing in Greater Boston, Economisch Statistische Berichten, 16-11-1983, pp. 1059-1063.

Malecki, E.J., Locational Trends in R & D by large U.S. Corporations, 1965-1977, Economic Geography, vol. 55, 1979, pp. 309-323.

Malecki, E.J., Corporate Organisation of R & D and the location of technological activities, Regional Studies, jg. 14, 1980.

Moore, B., R. Spires, The Experience of the Cambridge Science Park, OCDE-Workshop, on Research Technology and Regional Policy, Paris 24th-27th October 1983.

Organisation for Economic Co-operation and Development, Report of the Results of the Workshop on Research, Technology and Regional Policy, Paris, 1984.

Pred, A.R., City-systems in advanced economies, Hutchinson, London, 1977.

Premus, R., Location of high technology firms and regional development, Study Joint Economic Committee, US Congress, Washington, 1982.

Segal, N.S., Universities and Advanced Technology New Firms in Great Britain, International Workshop on the Future of Industrial Liaison, Technical University, Berlin, 1983.

Wever, E., Nieuwe bedrijven in Nederland, Van Gorcum, Assen, 1984.

DISCUSSIONS

Paper by S. Dresch

Discussion participants: R. Bolton, P. Joynt, A. Straszak, U. Loeser, L. Kajriukstis, S. Dresch.

Levely discussion centered around two issues:
How are regional problems and decisions delimited and formulated - are they substantially based or "merely" political?, and:
What is the link between science, education system etc. and technological and economic change?
With regard to the first question instances were quoted where regional problems arise in a natural way out of geographical and economic circumstances, waiting only for proper solutions, engaging also political structures. The cases quoted referred to riversheds and to geographico-economic East-West situation in South America, where large areas along the Western coast have much greater development capacity than is presently released, due to economic, but also political conditions.
As to the second question it was stated that the relations in question are of the necessary, but not sufficient condition type, so that simple reasoning can fail both ways. The situation is further made even more vague by the lack of clear definitions in the domain.

Paper by A. Mouwen and P. Nijkamp

Discussion participants: A. Straszak, R. Kulikowski, L. Lacko, S. Ikeda, A. Kochetkov, A. Mouwen.

This discussion, which to a large extent continued the themes of the paper itself and of discussion to the previous paper, focussed mainly on conditions and mechanisms of knowledge and technology transfer from science to production practice. Within this context social and spatial mobility of scientists, research centers and knowledge-intensive firms was assessed. Instances were quoted of large, scientifically self-sufficient firms moving out of bigger urban centers, with the small ones

moving in, for instance, to get closer to the research resources. On the other hand the example of Tsukuba was shown to indicate the real possibility of speeding up the regional development around a large scientific compound - by attracting businesses which could profit from cooperation. This development occurred over 15 years, and there is another one, chip-oriented, underway in Japan in the Kyushu region. Thus, while it was deemed important to secure the link between science and actual promotion, other conditions may play an important role, e.g. communication infrastructure or competitiveness. Experience from one place may not be fully transferable to another, and hence differences between the Dutch and the Swedich case. Knowledge-based development requires special orientation of investments - it was said that in the case of the Netherlands approx. 4% of GNP would be devoted R and D.

Paper by K. Polenske and Wm. Crown

Discussion participants: G. Bianchi, P. Joynt, K. Polenske.

The main question raised concerned the way in which the interregional coefficients can be obtained, since this was deemed to be far more difficult than for the technical coefficients. The procedure taken in the work presented started with trade tables, on which a balancing is performed. Then goals transportation data come in. Both these steps, however, do in fact still leave out some cells in the matrix. Hence, an expert-based range estimation is applied and final row and column balancing is performed. The whole procedure is implemented with two main computer programs MATHER and PASSION.

Paper by T. Vasko

Discussion participants: M. Steiner, A. Straszak, J. Owsiński, T. Vasko.

First, a clarification was asked for as to the meaning of information space. The answer consisted in statement that a general innovation is composed of simple innovations such as market innovation, product improvement etc., and that any simple innovation can hardly have an economic effect. Thus, innovations appear as compounds in the simple innovation space.

Then, a portion of discussion was devoted to identification of the logistic curves involved. Besides the very identification question, where the starting time-point was deemed of special importance, the problem of interplay of product values: exchange value, use value and production cost, was emphasized. Answering another question the speaker said that by looking at the innovations side he gets the idea that the new general economic upswing has had began by then, but that other analysts, e.g. C. Marchetti, see it coming in only about a decade.

Paper by R. Funck and J. Kowalski was not discussed since it was presented after the workshop.

ZTI OIN PAN, zam.70/66, nakł.70+18 egz.nr 343

ADDRESS
6, NEWELSKA ST.
01-447 WARSAW
Tel. 36·44·14, 36·81·50
Telex: 812397 ibs pl