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A M S T E R D A M

NEW TECHNOLOGY AND REGIONAL DEVELOPMENT

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Abstract

New Technology and Regional Development

Peter Nijkamp

This paper focuses on the regional development dimensions of the new technology sector, which is generally regarded as one of the driving forces behind structural economic changes reflected inter alia in long waves.

A first aim of the paper is to demarcate more precisely the term 'new technology'. Various features of this concept are discussed, while finally - instead of a cross-section approach - a selective sector approach is used to define the new technology sector.

A second aim of this paper is to analyse the locational patterns of new technology, based inter alia on concepts like agglomeration economies and incubator functions of the new technology.

Finally, a third aim of the paper is to describe a case study on regional dimensions of the new technology sector in the Netherlands. It is concluded that this sector is not necessarily concentrated in big cities, but exhibits a more scattered spatial configuration, although it is oriented toward the breeding place function of large cities (the 'urban climate' hypothesis).

1. Introduction

In the history of economic thought technology has almost never been treated as an explicit subject matter. Technology was mainly regarded as a datum for economic analysis (the so-called 'data crown' hypothesis; see Eucken, 1950). In recent years however, a profound interest in causes and effects of technological changes - seen from an economic viewpoint - has emerged. The economics of technological change has come to the fore as an intriguing research issue (see Stoneman, 1983, e.g.).

In the past years technological innovation has also been interpreted in the context of Schumpeter's view on technological revolutions as driving forces behind the Kondratieff cycles (see also Kleinknecht, 1984). Especially clustered innovations have in the past exerted a profound impact on western societies (railways, electricity, automobiles etc.). The introduction of new technologies requires a 'basic science' connected to 'technical exploitation', followed by 'imaginative laps' that precede all upswing phases in a Kondratieff long wave (see also Rothwell and Zegveld, 1981).

Much scientific discussion has also emerged on the question whether new technologies are a result of a demand pull or a technology push. A great deal of confusion in this field has however arisen because of a fuzzy use of the term new technology, especially because the motives and impacts of process, product, institutional and managerial innovations may be quite different.

Technology as the 'society's pool of knowledge regarding the industrial arts' (Mansfield, 1968) is however not a homogeneous knowledge asset, but is marked by a wide variety of different appearances ranging inter alia from small-scale to large-scale forms and from traditional to advanced activities. In the past years, much attention has been focused on new technologies, as it is a widely held belief that technological change may be one of the driving forces for new economic progress in an era of stagnation and structural change (cf. Nelson and Winter, 1982, and Rosegger, 1980). However, the terms 'new technology','advanced technology' or 'high technology' are not unambiguously defined and deserve closer attention. In the paper an attempt will be made at demarcating more precisely the meaning of the concept 'new technology'.

A second aim of the paper is to analyze the locational patterns of new technology. For instance, in recent years it has often been claimed that large metropolises are loosing part of their innovative potential with regard to large firms in favour to medium-size cities (see Malecki, 1983). In the light of the uneven geographical distribution of the new technology sector, it may be an important research objective to identify the economic motives for locational behaviour in the new technology sector.

Finally, the present paper will describe a case study for the Netherlands on the location pattern of new technology activities. It will be concluded that the new technology sector is not necessarily located in large cities, but may exhibit a more scattered spatial configuration although it is at least oriented toward the breeding place function of large cities (the 'urban climate' or 'incubator' hypothesis).

2. New Technology in an Era of Change

Technology is not a datum in entrepreneurial behaviour, but may be one of the instruments to improve the relative economic position of a firm. Clearly, there must be a need for employing this instrument in a competitive system. In addition, the financial resources, capital and entrepreneurship must provide the conditions for technological changes. Other important prerequisites for technological innovation are the availability of an appropriate (external) knowledge infrastructure like transfer centres, science parks and knowledge centres (see Mouwen and Nijkamp, 1985) and a sufficient level of (internal) R & D investments (see Andersson and Johansson, 1984).

New technologies imply that inventions are successfully transformed into innovations which are technically feasible and commercially attractive. This implies a successful implementation of new products or production processes, and a successful introduction of related management and marketing changes (including the search for new markets or new market segments). Consequently, technological innovations require also a successful use of new information technology (NIT), as the information infrastructure is an essential ingredient in any (private or public) development strategy (see also Gillespie et al., 1984).

Technological innovation has also a close link to the product life cycle. The various (successful) stages of a new product require special technological changes and R & D efforts. First of all, the phase of invention and introduction of a product requires a close orientation toward both R & D divisions and sales markets. Next, during the expansion phase more attention is needed for an increase of product standardisation and labour productivity, given the competition with other entrepreneurs on the same market. In the third stage, an orientation toward more capital intensity and product export is necessary in order to prevent a stagnation in sales. And finally, in the maturity stage both domestic and foreign competition becomes so strong that - unless new market segments are created through increased product specialisation or a cooperation with competitors is realized - a decline will commence.

Each phase of such technological innovations may have its own specific R & D and technology requirements, as well as its own specific locational requirements

(see also Brotchie et al., 1985, and Stöhr and Schubert, 1984). Consequently, regional development is co-determined by the life cycle phase of a new technology (see also section 3).

The demarcation of new technology - in contrast with other technology - is not an easy task. In principle, two different approaches can be distinguished, viz. the cross-section approach and the selective sector approach.

The cross-section approach examines all sectors of the economy and attempts to identify - on the basis of detailed surveys - the share of technological innovations (especially advanced technology) in each individual sector (for instance, by assessing the R & D input in each individual sector). This is a useful research strategy, although it is a fairly time-consuming approach which does not always give accurate answers (see Kleinknecht and Mouwen, 1985, and Mouwen and Nijkamp, 1985).

The selective sector approach tries to identify those sectors in the economy which are characterized by a high degree of use of new technology activities. The main problem here however is the definition of new technological activities, especially because a broad sectoral classification would not be satisfactory.

In the literature, various definitions of new (advanced or high) technology have been given. Despite a certain vagueness or fuzziness in the terminology (cf. Haustein, 1982), various attributes of new technology can be identified. In general, new technology is marked by:

- the use of highly skilled employees, many of them arescientists or engineers (Doody and Munzer, 1981; Rogers and Larsen, 1984)
- a high ratio of R & D expenditures to sales (Doody and Munzer, 1981; Hall and Markusen, 1983; Premus, 1982; Rogers and Larsen, 1984)
- a nation-wide or world-wide market for the products(Doody and Munzer, 1981; Rogers and Larsen, 1984)
- a fast rate of growth (Doody and Munzer, 1981; Hall and Markusen, 1983; Rogers and Larsen, 1984)
- a high degree of labour intensity in the production stage (Doody and Munzer, 1981, Premus, 1982).

In conclusion, the new technology sector can mainly be found in technically-oriented industries based on scientific and technological practices which lead to a relatively high growth rate of value added. Examples of such industries are: chemics, electronics, aircraft and instruments.

It is clear that a sharp definition and identification of the new technology is hard to give, because of rapid changes in many industrial sectors, incomparability of technological information, a firm's specific position in a product cycle,

lack of disaggregate empirical data on production processes at the micro level (even at the level of divisions or plants within one firm), and lack of a sharp distinction between new technology products and new technology processes (see also McQuaid and Langridge, 1984).

In the present paper the attention will mainly be focussed on firms (or industrial sectors) producing new technology products and which are to a large extent marked by the abovementioned features. For practical reasons, in the empirical part the selective sector approach will be used, so that major attention will be given to a selected set of (fairly detailed and disaggregated) industrial sectors which comply with the abovementioned features.

3. The Location of New Technology Firms

The locational analysis of new technology firms is still underdeveloped: a clear theoretical framework is lacking, while various case studies provide sometimes only anecdotal observations (see Malecki and Varaiya, 1985).

Nevertheless, a few more structural spatial development patterns seem to emerge. New technology firms are increasingly dividing their activities into routine (or standardized) and non-routine (or innovative) operations. The non-routine (mainly R & D-oriented) activities tend be concentrated in only a few locations marked by significant agglomeration advantages such as a good geographical accessibility. For instance, Hekman (1980) indicates that American computer firms tend to maintain their innovative activities in only a few regions (like California, Texas or Massachusetts). Standardized production and assembly operations are either moving into small towns or peripheral areas or into low wage Third World countries (cf. Bluestone and Harrison, 1982).

Next, non-routine activities in the new technology sector relies heavily on skilled and professional labour input, so that also the quality of the residential climate (including socio-cultural amenities) becomes a major locational motive for high technology firms (see also Brotchie et al., 1985, and Hall et al., 1983). Similar results were found by Oakey (1981) in a study on the British instruments sector, who came to the conclusion that skilled workers largely determined the location of production. This result was supported by Malecki (1984) and Oakey (1983) who observed that locational preferences of technical personnel exert a large influence on the location decisions of R & D. This personnel appeared to attach a high priority to cultural, educational and employment opportunities in urban areas.

With regard to routine activities, especially of multi-plant corporate organizations, it is evident that low-skill labour is still the main input. In as far as low-skill employment is abundantly present in various regions, it is mainly the

wage level which is determining the locational pattern of these standardized activities (see Hansen, 1980). It should be added however, that these activities may fairly capital intensive, so that ageing and life cycle processes of capital stocks may also exert a significant long-term impact on industrial location patterns of new technology firms.

In addition, it has to be mentioned that a large concentration of new technology activities may lead to congestion phenomena, especially if innovative firms create spin-off effects which lead to a rise in routine activities. Premus (1982), for instance, observed that in recent years there is a tendency of American new technology firms to move from the Sunbelt-states to the Mid-West due to bottleneck factors (such as high wage rates, high land rents, insufficient areas for industrial expansion, high local taxes and traffic congestion). Clearly, this 'crowding out' phenomenon may also be related to the firm's position in a product cycle. Similar results were found for Scotland by Cross (1981) for the Netherlands by Hoogteijling et al. (1985) and Wever (1984), and for Germany by Wettmann(1983).

Another (important) locational determinant of the new technology sector is its orientation toward an accessible communication and information network (see also Thwaites, 1982), so that this sector is either located in nodal points of a physical communication infrastructure or in areas near research and educational institutes (Levy, 1983). This may also lead to job-hopping, for instance, in the Silicon Valley.

A final relevant component of an innovation infrastructure of the new technology sector is the availability of venture capital (Rothwell, 1982), especially in those countries which are marked by regional variations in the provision of venture capital. This may especially hold true for large countries (like the USA) with segmented markets for venture capital. In small countries however, it is plausible to assume that regional differences in venture capital hardly exist, so that this is not a location-specific factor (though it may be generic determining factor for new technological innovations in the country as a whole).

The foregoing remarks lead to the following propositions which will be further tested in an empirical study on the locational pattern of the new technology in the Netherlands:

- Non-routine (R & D-oriented) new technological activities are sensitive to communication, information and accessibility, so that their location may be expected in nodal points of a spatial network
- Routine (standardized) new technological activities and operations may exhibit a more scattered pattern due to crowding out effects
- New technological activities recruiting highly skilled employees attach a high priority to a favourable residential climate near major urban agglommerations

- The location of the new technology will not be influenced by the wage level and the presence of venture capital, in as far as in a small country significant regional differences in these locational factors do not exist.

These propositions will now be examined in the context of a Dutch case study on new technology.

4. Location of New Technology in the Netherlands: a Test

Following the arguments put forward in sections 2 and 3, we shall first in the present section pay attention to the operational demarcation of high technology sectors in the Netherlands and to the operational definition of locational determinants of the new technology (see also Bouman et al., 1985).

The conventional sectoral subdivision of Business Week - Data Resources is based on 5 categories: energy, agriculture, high technology, services, and old line industries. For our case study, based on the abovementioned selective sector approach, the following activities in the Dutch economy at a 4-digit standard industrial classification are assumed to belong to the new technology sector:

code of a standard industrial classification in the Dutch economy	new technology sectors in Dutch economy
3581	office equipment
3593	weighing instruments and retail equipment
3693	electric and electronic measurement and control equipment and electromedical equipment
3694	telecommunication and signal equipment
3695	radio, television and electronic equipment
3771	aircraft
3811	medical, surgical, dental and veterinarian instruments
3821	measurement and control instruments
3831	optical and phototechnical instruments
3841	clocks and watches

Table 1. New technology sectors in the Dutch economy.

This classification is mainly based on the design of new products; the use of high tech products by other sectors is left out of consideration, as the use is not regarded as a new technology activity per se (unless the use of such products is necessary for designing more advanced new technology products, as is the case in

the medical sector, the robotics sector and the optical industry).

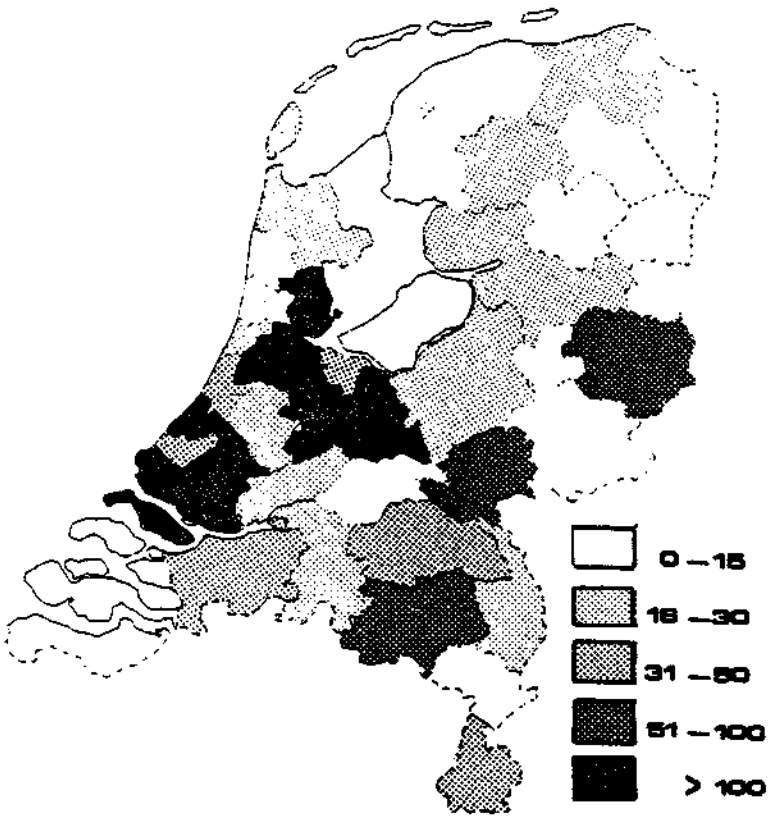
The spatial dispersion of new technology firms in the Netherlands has been analysed on the basis of a sample among firms in the sectors included in Table 1 (provided by the Dutch Chambers of Commerce). The location of all new technology firms could be derived from this sample, so that a detailed insight into the geographical pattern of the new technology sector in the Netherlands could be obtained. Some results will briefly be presented here. Table 2 contains a representation of the spatial dispersion at the provincial level in the Netherlands, based on the location quotient (the ratio of the provincial share of the new technology sector with respect to provincial share of the total industrial sector).

	no. of new technology firms		no. of industrial establishments		location quotient
province	abs.	%	abs.	%	
Groningen	36	2.8	1499	3.2	0.88
Friesland	26	2.0	1860	4.0	0.55
Drente	26	2.0	1005	2.2	0.90
Overijssel	76	5.0	3365	7.3	0.69
Gelderland	119	9.2	5748	12.4	0.74
Utrecht	129	10.0	2902	6.3	1.59
Noord-Holland	268	20.8	8405	18.1	1.15
Zuid-Holland	340	26.4	9220	19.9	1.33
Zeeland	22	1.7	1026	2.2	0.77
Noord-Brabant	159	12.4	7579	16.3	0.76
Limburg	73	5.7	3545	7.6	0.75
Zuid-Ysselmeer	13	1.0	253	0.5	2.00
Total	1287		46407		

Table 2. Location quotient for Dutch new technology firms.

Table 2 leads to the clear conclusion that the new technology sector is over-represented in the three industrialized and urbanized provinces (the so-called Randstad or Rimcity). These results seem to confirm conventional wisdom that the new technology sector is very much oriented toward large-scale agglomerations in which an urban and industrial character prevails.

However it is interesting to provide some results at a more spatially disaggregate level (the so-called COROP-level marked by 40 nodal regions). These results are presented in Map 1.



Map 1. No. of regional technology establishments.

This map demonstrates a slightly different pattern. It is still evident that various nodal regions in the three abovementioned urbanized and industrialized provinces are characterized by an overrepresentation of new technology firms, but this does certainly not hold for all nodal areas in the provinces. Some nodal areas appear to have even a strong underrepresentation of new technology firms. Furthermore, various regions outside the Randstad appear to have a fairly strong new technology orientation as well. Consequently, ecological fallacy may lead to a biased interpretation of the actual spatial distribution of new technology firms. The same pattern as presented by Map 1 was obtained by examining the spatial dispersion of the new technology firms in terms of employment. A first look at Map 1 suggests that the locational pattern of new technology is closely related to the presence of an urban agglomeration marked by a high degree of accessibility and of R & D infrastructure. Similar results have been found for the USA by Premus (1982) and for France by Aydalot (1984). These results suggest also that the diffusion of high technology firms does not exhibit a hierarchical distance-decay

pattern from the centre, but rather a multiple nuclei pattern. This pattern can be further analysed by examining the locational determinants of the new technology sector.

An operational definition of the locational determinants discussed in the previous section is a far from easy task. The following indicators based on available Dutch data have been used:

(1) education: the regional share of high-skill employees in the total regional labour force.

(2) R & D infrastructure: the (weighted average) distance of each regional main centre with respect to all R & D centres (university institutes, public research institutes, technology and transfer centres, and the like)

(3) amenities: a (weighted) socio-cultural index constructed on the basis of the regional availability of recreational facilities, monuments and cultural facilities (standardized for the number of inhabitants per region)

(4) venture capital: the regional supply of venture capital provided by (publicly financed) regional development corporations.

(5) urbanisation: the share of regional population living in big cities.

An econometric test of the validity of these locational determinants at the provincial level would lead to unreliable results in the light of the low number of provinces (12). Therefore, an adjusted approach has been adopted here. From our literature survey it has become clear that at least a ranking of the order of importance of these locational determinants can be derived. In most cases, an orientation towards large agglomerations is regarded as an extremely important explanatory factor for the spatial pattern of the new technology sector (indicator (5)), followed by high-skill educational facilities (indicator (1)) and R & D infrastructure (indicator (2)), while amenities (indicator (3)) and venture capital (indicator(4))have usually a much lower ranking. Based on expert views and intuition, the following weight coefficients have been used in an explanatory model for the geographical distribution of the new technology firms (Table 3).

location indicators	(1)	(2)	(3)	(4)	(5)
weights	0.25	0.2	0.1	0.1	0.35

Table 3. Weights attached to locational determinants.

By calculating next by means of a linear model the expected geographical dispersion of new technology firms, based on the weights in Table 3 and the actual regional observations on the locational determinants (1) - (5), a fairly satisfactory result

is obtained: 96 percent of the variance in the actual geographical pattern of new technology firms is explained by the weights in Table 3. A check by means of a regression model confirmed the results for the main indicators (1), (2) and (5), while for the remaining indicators insignificant results were obtained.

5. Retrospect

The following conclusions can be inferred from the abovementioned case study. Not all propositions mentioned in section 3 could be tested due to the limited empirical data on the locational pattern and motives of new technology firms. The available data however support the hypothesis that new technology firms tend to locate on nodal points of an accessible network, with a strong orientation towards large urban agglomerations. This bias against the urban 'milieu' is once more favoured due to the high-skill and R & D requirements of new technology firms. Crowding out effects could be observed in two respects: (1) the trend toward a sub-urban location (with a favourable living climate) of new technology firms, and (2) the trend toward an urban location in intermediate and/or peripheral areas. Regional differentiation of wage levels and of the supply of venture capital could hardly be observed in the Netherlands, so that these factors vanish as explanatory determinants of the geographical location pattern of the new technology sector. And finally, due to lack of available data on routine versus non-routine data at the firm level, the spatial differentiation between routine and non-routine new technologies could not be examined. The overall conclusion is that the empirical evidence from the Netherlands supports most hypotheses offered by the present literature, while the differences that are occurring are mainly due to the spatial scale of the country.

Our findings on the metropolitan orientation of the new technology sector have various policy implications: a regional development policy focussing on new technology should take the metropolitan area as its geographical base. In this area the conditions for new technology location have to be favoured by supporting the development of contact and information flows, as this determines the comparative advantage of the area (cf. Brotchie et al., 1985). Such agglomeration advantages are of utmost importance for the creation of advanced knowledge and creativity (requiring inter alia advanced educational institutes and R & D centres). The economic potential of such agglomerations is thus strongly determined by public overhead capital inducing the development of the new technology sector.

References

Andersson, A., and B. Johansson, Knowledge Intensity and Product Cycles in Metropolitan Regions, Working Paper, IIASA, Laxenburg, 1984.

Aydelot, Ph., Crise & Espace, Economica, Paris, 1984.

Bluestone, B., and B. Harrison, The Deindustrialization of America, Basic Books, New York, 1982.

Bouman, H., T. Thuis & A. Verhoef, High Tech in Nederland, Research Memorandum, Dept of Economics, Free University, Amsterdam, 1985.

Brotchie, J., P. Newton, P. Hall, and P. Nijkamp, The Future of Urban Form, Croom Helm, London, 1985.

Cross, M., New Firm Formation and Regional Development, Gower, Aldershot, 1981.

Doody, E.J., and H.B. Munzer, High Technology Employment in Massachusetts and Selected States, Massachusetts Division of Employment Security, Boston, 1981.

Eucken, W., The Foundation of Economics, Hodge, London, 1950.

Gillespie, A., J. Goddard, F. Robinson, I. Smith and A. Thwaites, The Effects of New Information Technology on the Legs Favoured Regions of the Community, Centre for Urban and Regional Development Studies, Newcastle, 1984 (mimeographed).

Hall, P. and A.R. Markusen, Technology Innovation and Regional Economic Development, Berkeley, 1983.

Hall, P., A.R. Markusen, R. Osborn and B. Wachsman, The American Computer Software Industry: Economic Development Prospects, Built Environment, vol. 9, 1983, pp. 29-39.

Hansen, N., Dualism, Capital-Labor Ratios and the Regions of the U.S.: a Comment, Journal of Regional Science, vol. 20, 1980, pp. 401-403.

Haustein, H.D., Innovation Glossary, IIASA, Laxenburg, 1982.

Hekman, J.S., The Product Cycle and New England Textiles, Quarterly Journal of Economics, vol. 94, 1980, pp. 697-717.

Hoogteyling, E., J.W. Gunning, and P. Nijkamp, Spatial Aspects of Innovation and Employment: Dutch Results, Innovation, Employment and Spatial Dynamics (P. Nijkamp, ed.), Springer Verlag, Berlin, 1985 (forthcoming).

Kleinknecht, A., Innovation Patterns in Crisis and Prosperity, Ph.D. Diss, Dept of Economics, Free University, Amsterdam, 1984.

Kleinknecht, A., and A. Mouwen, Innovatie (R&D) en Regio, Innovatie en Regio (W. Molle, ed.), Staatsuitgeverij, The Hague, 1985, p. 125-140.

Levy, J. M., Economic and Social Factors Influencing Future Industrial Land Use in the U.S., International Workshop, Canada, 1983.

Malecki, E.J., Technology and Regional Development, International Regional Science Review, vol. 8, no. 2, 1983, pp. 89-125.

Malecki, E.J., High Technology Growth Policies and Prospects for Local Economic Development, Journal of the American Planning Association, vol. 50, 1984, pp. 262-269.

Malecki, E.J., and P. Varaiya, Innovation and Changes in Regional Structure, Handbook Regional Economics (P. Nijkamp, ed.), North-Holland Publ. Co.. Amsterdam, 1985 (fortcoming).

Mansfield, E., Technological Change, Norton, New York, 1968.

McQuaid, R.W., and R.J. Langridge, Defining High Technologies, Canterbury, 1984.

Mouwen, A., and P. Nijkamp, Knowledge Centres as Strategic Tools in Regional Policy, Research Memorandum, Dept of Economics, Free University, Amsterdam, 1985.

Nelson, R.R., and S.G. Winter, An Evolutionary Theory of Economic Change, Harvard University Press, Cambridge, Mass., 1982.

Oakey, R.P., High Technology Industry and Industrial Location, Gower, Aldershot, 1981.

Oakey, R.P., New Technology, Government Policy, and Regional Manufacturing Employment, Area, vol. 15, 1983, pp. 61-65.

Premus, R., Location of High Technology Firms and Regional Economic Development, OECD, Paris, 1982.

Rogers, E.M., and J.K. Larsen, Silicon Valley Fever - Growth of High Technology Culture, New York, 1983.

Rosegger, G., The Economics of Production and Innovation, Pergamon, London, 1980.

Rothwell, R., The Role of Technology in Industrial Change, Regional Studies, vol. 16, no. 5, 1982, pp. 361-369.

Rothwell, R. and W. Zegveld, Industrial Innovation and Public Policy, Francis Pinter, London, 1981.

Stöhr, W., and U. Schubert, Ansätze fuer eine Koordinierte Wirtschaftspolitik in der Landerregion Ost, Regional-Okonomische Anelysen für Osterreich (G. Rüsch and W. Schönbeck, eds.), Orac, Vienna, 1984.

Stoneman, P., The Economic Analysis of Technological Change, Oxford University Press, Oxford, 1983.

Wettmann, R.W., Technological Development in a Regional Context: The Case of Germany, Paper OECD Workshop on 'Technology and Regional Policy,' Paris, 1983.

Wever, E., Nieuwe Bedrijven in Nederland, van Gorcum, Assen, 1984.

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