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## Constitution and consequences of a regional innovation system - the case of knowledge intensive industries in the Oulu region, Northern Finland

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REGIONAL COHESION AND COMPETITIVENESS  
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Constitution and consequences of a regional innovation system – the case of  
knowledge intensive industries in the Oulu region, Northern Finland

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**Abstract**

Since the mid-1970s, the Finnish industrial structure has been rapidly moving from factor-driven towards technology-driven industries. This development has been especially strong in some regions. In Northern Finland new jobs are concentrating on high tech industries of the Oulu region. The Oulu region is considered a new type of industrial district, which has some special characteristics. The local authorities, university, research institutes, local science park and network interdependence between large enterprises and SME play essential role. These are features commonly connected to the concept of regional innovation system (e.g. Cooke 1998). Our approach is near that of Cooke, i.e. comprehensive, not confining itself to a systemic approach only.

The aim of this paper is to study the innovation system in the Oulu region as follows:

- its main institutional conditions,
- main factors and actors contributed its constitution,
- consequences to the regional development.

Our approach is descriptive and comprehensive, not confining itself to testing hypotheses. Theoretical framework is interdisciplinary combining elements from industrial and economic sociology, economics and political science. Methods used for empirical findings are both qualitative and quantitative: e.g. interviews of key actors, filed material of enterprises and the authorities and analysing many-sided statistics.



## **2. Introduction**

In the beginning of 1998 there were 452,000 inhabitants in the Province of Oulu. The Oulu region, which consists of six rural municipalities besides the city of Oulu, had 164,000 inhabitants, 76,200 of which belonged to the work force. The unemployment rate was about 15 percent, which means that the number of employees was about 65,000. During the depression in the early 90s almost 10,000 jobs disappeared from different industries in the Oulu region, a deficit which the growth of the technology intensive industries has not been able to cover. The population in the Oulu region is growing quickly as a consequence of migration from the peripheries of Northern Finland. The unemployment rate in the region remains high, because the net employment does not grow at the same pace as the migration (Provincial Government of Oulu 1998).

In 1998 technology intensive industries had more than 11,000 employees in the Province of Oulu, about 1,500 of which were working in education and research. The industries as well as education and research were being concentrated in the Oulu region. The number of employees was about 8,000. In comparison, the number was only 4,000 in 1992. The telecommunication industry dominates the high tech industries in the province: in 1998 it employed 63 percent of the work force and covered 67 percent of the turnover and 80 percent of the high tech export. This telecommunication cluster is being accumulated around the global enterprise Nokia (with about 4,200 employees in the Oulu region in 1998), but even many other enterprises in the cluster have grown so big that they have global business activities besides the local ones. (Business Review of Oulu region 1998, Ahokangas et al. 1999, Nokia)

The Oulu region is considered a new type of industrial district with some special characteristics. The local authorities, the university, the research institutes, the local science park and the network interdependence between large enterprises and SME play an essential role in the new development. These are features commonly connected to the concept of regional innovation system (e.g. Cooke 1998).

We are going to describe a regional innovation system with the help of the development of knowledge intensive industries in the Oulu region. An interdisciplinary approach gives us tools to operationalise this both theoretically and empirically complicated task. In our paper we aim to present some theoretical aspects and empirical findings in a broad outline. Our research combines both qualitative and quantitative methods. The most important method for new information has been interviews with some key actors. We have carried out about 50 interviews, the results of which, however, will not be reported in this paper. Nevertheless, the information from the interviews has affected the writing of this paper.

The research covers quite a long time span, from the 60s to the present. In order to achieve a better understanding of the present and the future, we want to focus on how former activities have moulded the structures and conditions of later development. The structure of the paper is as follows. In section two different theoretical possibilities to describe a regional innovation system are discussed. The main theoretical premise is based on the importance of different networks in the constitution of a regional innovation system. In section three we outline the significance of regional institutions like education and research, technology intensive industry and local industrial policy. We illustrate how different actors have contributed to the formation of the Oulu phenomenon. In section four we draw some conclusions about the constitution of the techno-economic networks in the Oulu region and the contribution of the technology intensive industries to the regional development.

## **2. Theoretical background**

### **Regional innovation system**

The concept of regional innovation system is based on two different research traditions. Regional science has been interested in the diffusion, utilisation and consequences of new technology in regional development. In the late 1980s and in the beginning of the 1990s the discussion was on a more general level (Cooke 1998, Malecki 1991, Bergman et al. 1991, Antonelli & Momigliano 1981, Cooke 1985, Aydalot 1985, Maillat & Vasserot 1988, Maillat 1991, Rothwell & Dodgson 1991, Meyer-Krahmer 1985, Camagni 1991). The concept of regional innovation system has been influenced by literature on high technology complexes, technopoles and new technology industries (see e.g. Saxenian 1994, Luger & Goldstein 1991).

Another theoretical background for the research of regional innovation system is the study of national innovation system, whose starting-point is Freeman's (1987) study of Japan's exceptional economic development in the 70s and 80s. In his concept of national innovation system Freeman combined features from the economic rise of Japan, such as the technology policy of the government, R&D in enterprises, the educational system and the industrial structure. (See Freeman 1987). The first actual studies regarding national innovation system were published in the early 90s. (See Lundvall 1992, Nelson 1993)

The previously prevailing outlook on innovation as a linear system has been rejected. Instead, an interactive view of the emergence of innovations has been adapted. Thus innovations have been tied up with the learning process, which is a concept highly dependent on personal contacts and a variety of milieu. This variety stems from different work experiences and sources of knowledge and the importance of sharing these experiences. Co-operation with separate actors makes the diffusion of experiences possible. Not only economic actors should be in collaboration, but even research institutes, higher education, vocational education, centres of enterprise services, advisers and public institutes should co-operate interactively sharing new technological knowledge. Interaction between actors is a potential source of learning. (See Lundvall 1992)

According to Cooke (1998, 11), when discussing an innovation system, it should be borne in mind that:

*...it is an open system in interaction with its environment... It remains necessary to distinguish between "operational" and "conceptual" systems.*

In the following we aim to illuminate the concept of regional innovation system from a regional science perspective by examining the concepts of innovative milieu and industrial district. These have been paid a lot of attention in recent literature on regional science and regional economics. In our view the Oulu region does not fulfil all the conditions of innovative milieu or industrial district because it does not have SME as the dominant type of enterprise. However, these concepts enable us to operationalise the concept of regional innovation system in the Oulu region.

The development of a regional economy can be approached by means of the concept of innovative milieu. According to this view, every regional economy is considered a field of social communication, mutual synergy and co-operation affecting the innovation capacity

and economic success in that region. This leads to a heightened feeling of togetherness, and the region is often associated with a special image of its own. (Camagni 1991)

On the other hand, the concept of industrial district is also often referred to. The economic success of a region often depends on the small enterprises being organised into co-operative networks. They work in the same line of business and achieve the benefits of large-scale production by means of specialisation and mutual subcontracting. The relations between the enterprises are confidential. They share information on new production methods, which helps all enterprises in the district to improve their efficiency. Even the geographical proximity improves the efficiency. (Sengenberger & Pyke 1992)

The two approaches do not exclude each other, but not until they are combined is one likely come close to a description of a regional innovation system. Innovative milieus and industrial districts come into existence only when the spontaneously developed enterprises in a region have developed a division of labour that reaches the level of co-operative organisations and continual innovations (Balloni & Iacobucci 1996)

According to Biggiero (1998) the vast literature on innovative milieus and industrial districts share the same core properties:

*IDs are also self-organising systems, because they have founded their positive externalities (economies of scope, specialisation and proximity) and learning ability on common values, tacit knowledge, past experiences and behaviours, which are internal to the same area. Social and professional communication networks are largely self-contained and developed within the district territory, sharing common knowledge, as languages, cultural and social values.*

### Social capital in innovation system

According to Cooke and Morgan (1998, 25–27) the national innovation system is, in a broad sense, composed of the following six factors: (1) the role of R&D, (2) the ensemble of education and training institutes, (3) the financial system, (4) the network of user-producer relationships, (5) the intermediate institutions (e.g. trade associations, local chambers, regional technology transfer centres) (6) the social capital. The first five factors are a sort of components of networks on many levels. The sixth factor, the social capital, operates as a kind of lubricant in network junctions. Most factors involved in innovation systems can also be found in developed regional economies. Research on regional innovation systems is largely a question of research on different networks.

Social capital refers to features of social organisation – such as trust, norms and relationships between people. These facilitate co-ordination and co-operation for mutual benefit. The concept of social capital is multidimensional because it consists of numerous incommensurable contributory factors. (Dasgupta 1997)

Coleman (1988) compares social capital with material and human capital as follows:

*Physical capital is wholly tangible, being embodied in observable material form; human capital is less tangible, being embodied in the skills and knowledge acquired by the individual; social capital is even less tangible, for it is embodied in the relations among people. Physical capital and human capital facilitate productive activity, and social capital does so as well'. (Coleman 1988, 304)*

In his research on the importance of networks in competition Burt (1992, 8–9) discusses three different types of capital: financial, human and social capital. Financial and human capital differ in two ways from social capital. First, they are the property of individuals. Second, financial capital is needed for raw materials and production facilities. Human capital is needed to craft the raw materials into competitive products. Social capital is the final arbiter of competitive success: through relations with colleagues, friends and clients come the opportunities to transform financial and human capital into profit.

In regional science the concept of social capital comes quite close the concept of embeddedness, which, however, is a broader concept than social capital. In its recent sense the concept of embeddedness was introduced by Granovetter (1985) (Portes & Sensenbrenner 1993). In regional science this concept, which originally comes from economic sociology, has taken numerous meanings (see Oinas 1998). In regions with networks social relations between mutually dependent actors that share a common goal are established. The development of network relations requires that the mutual dependence is recognised and accepted. In embedded network relationships co-operation is not based on hierarchical relations, but rather on loyalty, solidarity and trust. (Sotarauta 1998, 129). In the research on innovative milieu embeddedness is one of the key concepts (see Storper 1995; Maillat 1995; Hallin & Malmberg 1996).

### Triple helix

Universities and industry have until very recently been relatively separate institutional spheres, but they are nowadays assuming more tasks which formerly belonged to the other. The role of government in relation to the two above mentioned is also changing. A spiral model of innovation – the so called triple helix – is required to capture the multiple reciprocal linkages at different stages of the capitalisation of knowledge. The triple helix of academic-industrial-government relations seems to be a key component of any national or multinational innovation strategy in recent decades. In addition to technology policies, the model has also been used in the field of technology research. (See Etzkowitz & Leydesdorff 1995)

The triple helix approach is a kind of umbrella of theories rather than a single theory. In recent years a number of concepts have been proposed for modelling the transformation processes in relations between university, industry and government. For example the national innovation system has been compared with the regional ones. The approach also covers perspectives from the techno economic paradigm to the techno-economic networks (see Green et al. 1998). The triple helix approach has at least three main forms, where the helices are defined more or less institutionally or even as different communication systems. If the helices are defined institutionally, the model is premised upon separate institutional spheres (academic, industrial and governmental) and the knowledge flows among them. The models based on different communication systems are rather theoretical. There are some difficulties with the empirical basis of the triple helix and also in its normative implications, but as a whole the approach seems to be sufficiently complex to encompass the different perspectives of innovations, for example in case histories. The Triple helix is likely to contribute to future research, because of the importance of university-industry-government relations in knowledge intensive economies. (Leydesdorff & Etzkowitz 1998)

### 3. Historical basis of the knowledge intensive industries

#### History matters – path dependency

*Path dependency is like a cheetah sprinting full speed after an antelope. Out of the corner of its eye, the cheetah may see even bigger game, but it's already barreling after the smaller one, and changing course would require enormous energy. Therefore it's easier just to continue in the same direction. (Error! Bookmark not defined.)*

Path dependency stresses the significance of the former development to the present and future developments. According to path dependency different innovation processes develop in broad interaction during long periods of time. However, regional factors to success are not easy to follow, even if the development has been path dependent. (Sotarauta 1998, 130–131) This is why one also has to know the dynamics of the general development in the region. When studying a regional innovation system one has to keep in mind the possibility of too strong path dependency. Grabher (1992, 256) has described the formation such a 'lock in' as follows:

*Regional development became 'locked in' by the very socioeconomic conditions that once made these regions 'stand out against the rest'. In other words, they fell into the trap of 'rigid specialisation'.*

#### Birth and growth of knowledge intensive industries

The rise of knowledge intensive industries in the Oulu region has two main causes: it is partly due to the big industrial enterprises in the region directing into new lines of industry, partly due to the growth of Nokia, nowadays the largest enterprise in Finland. Since the 60s Nokia has transferred some of its business activities from the capital area of Helsinki to Oulu. Later even smaller enterprises were founded to related industries (also in software production), some of which have grown into medium size export enterprises.

Nokia started in the Oulu region with cable production in 1960, in fact many years before the electronic and telecommunication industries had been established in Finland. Nokia's second step in Oulu was to produce radio telephones for the Finnish army in 1972. The condition was that the production was to take place in an 'underdeveloped area' in Finland. Soon after the telecommunication production was initiated in 1973, 1975, 1981 and 1985, thanks to some incentives dealing with investments in the regional policy during that time. The actual R&D of mobile phones was launched in 1988. (Oksman 1996)

However, the first actual electronics enterprise in the Oulu region started in 1970 by the foundation of an electronics division of a local large-scale forest-industry enterprise. Also a state-owned big enterprise in steel industry was involved when the foundation of some electronics enterprises took place in the 80s. (Alatossava 1997, 26) Diversification in new industries was a common strategy in the 70s and 80s. Afterwards both of those large-scale enterprises have given up their production in electronics. Nevertheless, one can say that the old enterprises in 'heavy industry' have given an important contribution to the development in the electronics industries in the Oulu region. (cf. Lovio 1993)

Nowadays there are about 70 enterprises in knowledge intensive industries in the Oulu region, the focus being on electric industry, telecommunication and electronics. The sizes of



the enterprises vary from one-man micro enterprises to a large-scale enterprise with thousands of employees. In recent years, the telecommunication industry has concentrated on R&D, but electronics operates on a full scale from subcontracting to end products. The main enterprises in the region operate globally. The business actions are mainly of business to business type, demanding high know-how and trust between the partners. According to Alatosava (1997, 26), there are few enterprises in the telecommunications industry because Nokia has a dominating position in the field and has therefore been able to recruit almost all the newly qualified engineers effectively. However, the foundation of new enterprises is nowadays on a lower level in all industries in the Oulu region than in Finland in average.

There are about 200 enterprises in software production in the Oulu region. They produce both goods and services. The evolution in the software branch differs from the previously discussed. The production started in the early 80s and the number of firms has been growing ever since. There are no large-scale enterprises in the branch recruiting all the skilled programmers and system builders. The largest enterprise in programming production employs about 300 people, but usually the firms are small. Up to now the production has mainly involved subcontracting. Nokia is the largest customer in the region, but in fact the market area consists of the whole of Finland and some enterprises have also started to export their software.

Recently the software firms have been able to develop competitive market products with competitive potentials for the global market. This differs from the culture to which firms operating in business to business have got used to. There is a need for a new kind of know-how in business activities. The manager of a small software firm states it as follows.

*We are a small company concentrating on tailored software systems. Our customer relations are long-term oriented and based on mutual trust. Actually, there is no need for any specific marketing activities and therefore we do not have much professional marketing experience either.*

Nowadays many small high-tech companies in the Oulu region aim at entering the international market, which naturally functions in accordance with a business logic very different from the familiar local project business context. Project businesses and product businesses are at the extreme polar opposites along a continuum highlighting changes in business logic when moving from projects towards increased productisation. (See Alajoutsijärvi et al. 1999)

### Significance of education and research

The University of Oulu was established in 1959. There were three faculties in the university: the faculty of philosophy, the faculty of technology and the faculty of medicine. The department of electrical engineering started in the faculty of technology in 1965. The department started to educate engineers mainly for power plants and electricity works. Soon it was realised that this did not serve its purpose, because there were not enough possibilities to employ graduating electrical engineers in Finland. The first professor in the department worked for directing the education towards telecommunication engineering, which was considered to guarantee better possibilities for employment. (Salo & Lackman 1998, 27 and 533)

After the education was directed to information technology, the department started to co-operate in the field of research with industry. Nevertheless, the new direction of education and research was not enough. The first professor in the department recalls (Oksman 1996, 36) that there was no electronic industry in Northern Finland in the late 60s. A threat that all the graduating engineers would have to move to southern Finland for jobs made the staff in the department to propagate for getting some electronic industry to Northern Finland as well. The enthusiastic work led to a people's movement in the early 70s. However, the electronic industry was quite small in Finland and the birth of telecommunication industry was far in the future. The engineers graduating from the department in the early 70s were employed mainly with telephone operators all over Finland.

The foundation of electronic laboratories in Technical Research Centre of Finland in 1974 was also of great importance for the development of the electronic industry in the Oulu region. This was part of the regional policy. The decentralisation policy has had many advantages. The electronic laboratories in Oulu created functional relations between the university and industry in the field. One example of the co-operation is the development work on mobile phones since the 70s. (Michelsen 1993, 329)

In the early years the Technical Research Centre of Finland played even another central role in Oulu. The electronic laboratory was a significant employer of engineers graduating from the department of electrical engineering. This contributed to diminish the migration to Southern Finland, i.e. the leakage of human capital. Afterwards the laboratories also gave birth to some spin-off firms in the region.

### Industrial policy for knowledge intensive industry in Oulu

Oulu, the largest city in Northern Finland, is historically known as a centre of tar trade. After the tar trade ended at the end of the 19th century, the development of Oulu somewhat declined. There was not much local industry compared to the other industrial cities in the country, but Oulu was still the most industrialised city in Northern Finland. (Salo and Lackman 1998, 611)

After World War II the industrialisation in the Oulu region was based on state-controlled large-scale industry using natural resources. During the 70s the large-scale industry experienced a structural change in Finland. The industrial growth in the Oulu region declined once a gain because there was no lively SME population in the region. In the beginning of 80s the municipality of Oulu actually had two choices: to rely on support for declining industrial regions or to stress its own strength. The later option was chosen, which meant enhancing the co-operation between the university and industry.

An important step for interaction with industry and university was taken in 1982, when the local science park was established (nowadays Technopolis Oulu Plc). The model was got from Silicon Valley, although its realisation was original and partly innovative. The science park started in the buildings of a closed dairy downtown. The share capital was gathered according to public-private-partnership. The city of Oulu invested a million and the other half was raised from the industry.

The project was pioneering in Finland and the publicity which the science park got was very important for its survival. The positive publicity was not a lucky chance. As a part of its technology policy the city of Oulu started a Technopolis Oulu -project in 1984, in which the media was given positive news from the companies in the science park. This strengthened the image of Oulu as specialising in new technology industries. During the project even

direct interaction with the city of Oulu and the university got deeper. For example the city of Oulu financed a research agent employed in the university.

After physically moving near the university in 1985 Technopolis Oulu has grown fast. At present there is over one hundred enterprises in the science park with some 2,400 employees. The main lines of industry are telecommunication, electronics and information technology. (See <http://www.sciencepark.com>) The number of actual high-tech enterprises is about fifty the rest consisting mainly of service industries. This kind of structure is quite common among science parks internationally (Luger & Goldstein 1991, 5).

#### **4. Conclusions**

The development in the techno-economic networks in the Oulu region can be divided into two phases. During the early phase the push of technological education and research was important. Nowadays the business enterprises are likely to be in the centre of these networks. If we think of the development with help of the concept of innovation system, it seems that in the early phase innovations were made in a linear fashion. For the present innovations come about in a more interactive way. The interviews show that there might exist an interactive innovative system in the region, but it is difficult to define both institutionally and regionally. The core of the 'system' is industry, university and industrial policy, but it seems that the industrial policy is losing its importance.

One main feature in the construction of the techno-economic networks has been consensus among different institutional actors, not underestimating personal relations and mutual trust between key actors, which also seem to have had great importance. The co-operation between the city of Oulu, university, Technical Research Centre of Finland and industry has functioned well. According to the interviews Oulu has been big enough and distant enough from the capital area of Helsinki to become an independent and vital technological centre of Northern Finland.

For the present the high-tech industries are standing more and more on their own feet. (We don't discuss the structure and importance of the networks among the enterprises in this paper.) The connections to the other sectors of society are still important. For instance contacts with the education system are important because of the lack of technically educated personal. In fact the lack of educated people slows down the growth rate of high-tech industries. Some education projects to overcome these problems have been started. These and other projects among the actors in the techno-economic networks in the region could be called social innovations. In spite of the high rates of R&D the industry and especially large-scale enterprises still need the 'strategic basic research' done in the university.

The Oulu region has the same kind of features as the Route 128 region in the US, e.g. industrial activities gathering around one large-scale enterprise. All the same, the development in the Oulu Region has been very positive. In Route 128 area there has been a decline because of the difficulties in the large-scale enterprise. (See Saxenian 1994). The know-how in many enterprises is focussed only on R&D and different kinds of projects. One main issue is if these enterprises will be able to form the industrial structure needed for the development of a learning region.

Although the high-tech industries are growing fast, and the effects on the environment are mainly positive, there may be some negative features regarding regional economic development. When one enterprise grows into a regional giant it can steal resources

important for the growth of the other enterprises and other industries. The migration to the Oulu region from the peripheries of the Northern Finland causes problems to the development in these areas.

## **Literature**

- Ahokangas, P., M. Hyry, P. Räsänen (1999). Small Technology-based firms in a Fast-growing Regional Cluster. *New England Journal of Entrepreneurship*. Vol. 2.
- Alajoutsijärvi, K., K. Mannermaa, H. Tikkanen (1999). Customer relationship and the small software firm – A framework for understanding challenges faced in marketing. Unpublished paper.
- Alatossava, A. (1997). Made in Oulu – Yliopiston ja yritysten välisen yhteistyön kehittäminen. Pohjoinen, Saarijärvi.
- Antonelli, C.H., A. Momigliano (1981). Problems and experiences of regional policy in Italy. *Micros*, vol. 2.
- Aydalot, P. (1985). High technology industry and innovative environments. London. Routledge.
- Balloni, V., D. Iacobucci (1996). The Nature of groups and networks of small firms in traditional industry. In: *Developing core competencies in small businesses for the 21st Century*. Centre for Continuing Education. University of Vaasa.
- Bergman, E., G. Maier, F. Tödtling (1991). *Regions reconsidered*. London. Mansell.
- Biggiero, L. (1998). Italian Industrial Districts: An Evolutionary and Institutional View. In 'The Future Location of Research: a Triple Helix of University-Industry-Government Relations', New York City, January 1998, in: <http://www.chem.uva.nl/sts/loet/th2/index.html>
- Bourdieu, P. 1986. The Forms of Capital. In J. Richardson (ed.) *Handbook of Theory and Research for the Sociology of Education*. Westport, CT: Greenwood Press.
- Burt, R.S. (1992). *Structural Holes – The Social Structure of Competition*. Harvard University Press. Cambridge.
- Busines Review of Oulu Region. Nro 1/1998.
- Camagni, R. (1991). (toim.) *Innovation networks: spatial perspectives*. London. Pinter.
- Coleman, J. (1988). Social Capital in the Creation of Human Capital. *American Journal of Sociology* 94. (Supplement) P 95-120.
- Cooke, P. (1985). Regional innovation policy: problems and strategies in Britain and France. *Environment and Planning*, C 3.
- Cooke, P. (1992). Regional innovation systems: regulation in the new Europe. *Geoforum*, vol. 23.
- Cooke, P. (1998). Introduction: origins of the concept. In Braczyk, Hans-Joachim – Philip Cooke, P. – M. Heidenreich (eds.) *Regional Innovation Systems*. UCL Press, London.
- Cooke, P., K. Morgan (1998). *The associational economy – firms, regions, and innovation*. Oxford. Oxford University Press.

- Dasgupta, P. (1997). Social Capital and Economic Performance. Mimeo, Environmentally and Socially Sustainable Development Network. Washington, DC: The World Bank.
- Etzkowitz, H., L. Leydesdorff (1995). The Triple Helix: University - Industry - Government Relations - A Laboratory for Knowledge Based Economic Development. EASST Review Vol. 14 March 1995.
- Freeman, C. (1987). Technology policy and Economic performance – Lessons from Japan. Pinter Publishers. London.
- Grabher, G. (1993). The weakness of strong ties: the lock-in of regional development in the Ruhr area. In G. Grabher (ed.). The embedded firm – On the socioeconomics of industrial networks. Routledge. London.
- Granovetter, M. (1985). "Economic Action and Social Structure: The Problem of Embeddedness". American Journal of Sociology 91: 481-510.
- Green, K. – R. Hull – A. Mcmeekin – V. Walsh (1998). The Construction of the Techno-Economic: Networks vs. Paradigms. In 'The Future Location of Research: a Triple Helix of University-Industry-Government Relations', New York City, January 1998, in: <http://www.chem.uva.nl/sts/loet/th2/index.html>
- Hallin, G., A. Malmberg (1996). Attraction, competition and regional development in Europe. European Urban and Regional Studies, vol. 3.
- Leydesdorff, L. - Etzkowitz, H. (1998). The Triple Helix as a Model for Innovation Studies. In 'The Future Location of Research: a Triple Helix of University-Industry-Government Relations', New York City, January 1998, in: <http://www.chem.uva.nl/sts/loet/th2/index.html>
- Lovio, R. (1993): Evolution of Firm Communities in New Industries – The Case of the Finnish Electronics Industry. Acta Academiae Oeconomicae Helsingiensis Series A:92. Helsinki.
- Luger, M.I., H.A. Goldstein (1991). Technology in the Garden – Research parks & regional economic development. The university of North Carolina Press. Chapel Hill & London.
- Lundvall, B.-Å. (1992). National Systems of Innovation – Towards a theory of innovations and interactive learning. Pinter, London.
- Maillat, D. (1995). Territorial dynamics, innovative milieus and regional policy. Entrepreneurship & Regional Development, vol. 7.
- Maillat, D., J-Y. Vasserot (1988). Economic and Territorial Conditions Revival in Europe's Industrial Regions. in (ed.) Aydalot, P., D. Keeple. High technology industry and innovative environments: The European Experience. London. Routledge.
- Malecki, E. (1991). Technology and Economic Development. Harlow. Longman.
- Meyer-Krahmer, F. (1985). Innovation behaviour and regional indigenous potential. Regional Studies, vol. 19.
- Michelsen, C.-E. (1993). Valtio Teknologia Tutkimus – VTT ja kansallisen tutkimusjärjestelmän kehitys. VTT, Espoo.

- Nelson, R. (ed.) (1993). *National Innovation systems. A comparative analysis*. Oxford University Press, New York.
- Oinas, P. (1998). The embedded firm? Prelude for a revived geography of enterprise. Helsinki School of Economics and Business Administration. *Acta universitatis Oeconomicae Helsingiensis*. A-143.
- Oksman, J. (1996). Tietoliikenneteollisuuden taustat Pohjois-Suomessa - Revontulitutkimuksesta kännykkään. In: *Oulun Tiedepäivät III*, (ed.) J. Hirvonen & R. Vesikko, *Acta Universitatis Ouluensis F 6*. Oulun yliopistopaino, Oulu.
- Portes, A. – J. Sensenbrenner (1993). Embeddedness and Immigration: Notes on the Social Determinants of Economic Action. *American Journal of Sociology* vol. 98.
- Putnam, R., with R. Leonardi, and R. Nanetti. (1993). *Making Democracy Work: Civic Traditions in Modern Italy*. Princeton: Princeton University Press.
- Rothwell, R., M. Dodgson (1991). Regional technology policies. In: (ed.) Brothie, J., M. Batty, P. Hall, P. Newton. *Cities of the 21 st century*. Harlow. Longman.
- Salo, M. – M. Lackman (1998). *Oulun yliopiston historia 1958-1993*. Oulun yliopisto, Oulu.
- Saxenian, A. (1994). *Regional Advantage – Culture and Competition in Silicon Walley and Route 128*. Harvard University Press, Cambridge.
- Sengenberger, W., F. Pyke (1992). Industrial districts and local economic regeneration. In: Pyke & Sengenberger (ed.) *Industrial districts and local economic regeneration*. International Institute for labour Studies. Geneva.
- Sotarauta, M. (1998). Alue- ja suunnittelututkimuksen viestit tulevaisuuden tutkimukselle. *Futura* 4/1998.
- Storper, M. (1995). The resurgence of regional economies, ten years later: The region as nexus of untraded interdependencies. *European Urban and Regional Studies*, vol. 2.