National systems of production, innovation and competence-building

by

Bengt-Åke Lundvall, Björn Johnson, Esben Sloth Andersen and Bent Dalum, Department of Business Studies, Aalborg University

Paper to be presented at the Nelson and Winter DRUID Summer Conference, Aalborg Congress Center, Aalborg, Denmark, June 12-15 2001

National systems of production, innovation and competence building

Introduction

The four authors have worked individually and collectively on different aspects of innovation system-studies for more than a decade. Actually the common research program leading up to this concept was established more than 20 years ago (Andersen et al 1978 and Andersen et al 1979). This paper is an attempt to sum up this work and indicate in what direction we believe future work on innovation systems should go. In the first part we give some background on how the concept 'national system of innovation' has developed by drawing parallels to a radical technical innovation such as the computer. In the second part, we tell the story about how the Aalborg-version of the concept developed from being rooted primarily in production structure towards including all elements of the system contributing to competence building. We illustrate the approach empirically through results from a study of the Danish innovation system (the DISKO-project). In the last part of the paper we discuss how the concept could be adapted in order to be useful for the analysis of countries in the South. We end up by indicating a research agenda and in the appendix we introduce *GLOBELICS* as a concrete initiative aiming at promoting this agenda.

The national system of innovation concept seen as a radical innovation

When using a computer it is not necessary to know how and by whom it was invented, developed and introduced in the market. Neither is it always necessary in socio-economic research to know how specific analytical tools were shaped. But from time to time it may be useful to reflect on how a concept such as 'national innovation systems' came about and to see in what direction it tends to be developed.

In what follows we will draw parallels with the development of a radical innovation as the computer, *without, of course, implying any equal kind of importance of the two innovations*. Everybody seems to agree that the computer has changed the world, while most people live happily without having heard of national systems of innovation.

The unexpected diffusion

The modern version of the computer was not expected to become a widely spread artifact. In the fifties most national experts projected that each country would invest just in one (mainframe) computer in order to handle population statistics and similar big data sets.

When the idea about the innovation system approach was first discussed in the middle of the 80s nobody expected it to become as widely diffused as it is today. Today OECD, the European Commission and UNCTAD have absorbed the concept as an integral part of their analytical perspective. The World Bank and IMF have been more reluctant but even here change seems to be taking place. The US Academy of Science has recently brought

the National Innovation System into its vocabulary and now uses it as a framework for analyzing science and technology policy in the US. Sweden, has given the concept legitimate status in its own particular way by naming a new central government institution (an 'ämbetsverk') VINNOVA which stands for 'the Systems of Innovation Authority'.

It is of course interesting to speculate why the concept has diffused so rapidly among scholars and policy makers. One reason may be that mainstream macroeconomic theory and policy have failed to deliver an understanding and control of the factors behind international competitiveness and economic development. Another reason might be that the extreme division of specialization among policy institutions and policy analysts has become such a big practical problem that an analytical concept that helps to overcome these problems was welcomed not least among those responsible for innovation and science policy. It is our impression that the concept to begin with diffused to this more limited community but that it now tends to enter into circles of scholars and policy makers focusing on economic growth and development.

The focus on *national* systems is of course controversial in a context characterized by so-called globalization. Here one might think of 'the owl of Minerve flying in the dusk' and argue that it is only when an institution (in this case the nation state) is becoming seriously threatened that we begin to understand its importance and fundamental functions. But it is also important to note that most empirical studies of how far globalization processes have undermined national systems seem to indicate that the national level remains important for certain innovation activities (Archibugi and Michie 1995, Cantwell 1995 and Patel 1995). Actually it might be argued that the growing proximity and potential tension among national systems brought about by globalisation is a factor increasing the demand for understanding systemic differences among innovation practices that relate to international trade (Ostry and Nelson 1995).

A concept with its origin far back in history

The basic idea of the computer goes back to the 19th century when Babbage spelled out the basic principles and actually constructed a mechanical version that worked. But it took another 100 years before scientific and technological developments in different areas (in physics, material science and mathematics) made it realistic to construct a version that could be attractive to users.

Similarly, the concept 'national systems of innovation' goes far back in history. Actually it goes back to Friedrich List (List 1841). His concept 'national systems of production' took into account a wide set of national institutions including those engaged in education and training as well as infrastructures such as networks for the transport of people and commodities (Freeman 1995). It was focused on the development of productive forces rather than on allocation of given scarce resources. The concept challenged the 'cosmopolitan' approach of Adam Smith and it pointed to the need to build *national* infrastructure and institutions.

The modern version of the innovation system concept was not based upon any direct inspiration from List. It was only after the concept had become generally accepted that

Christopher Freeman and others went back and brought forward List as the intellectual ancestor. The most obvious linkage was perhaps in the development of the Aalborg-version of the concept where the role of the *home market* for innovations has some connections to the infant industry argument of List. But, even here, the direct inspiration came via Burenstam Linder who is a liberal economist and a former conservative minister in the Swedish government (Linder 1961) rather than directly from List.

Parallel innovative activities around the world

The progress toward a modern computer reflects parallel efforts from many individual scholars and research groups. There are many 'fathers' and 'mothers' to this invention. In this as in many other fields it happens time and again that similar breakthroughs take place at the same time in different locations. There is something in the air – technical opportunities and market demand – that makes the situation mature for new specific innovations to be introduced in parallel.

A similar pattern can be discerned in the case of the innovation system concept in spite of the fact that the 'market' and 'demand side' is more difficult to define when it comes to intellectual concepts. The idea of a national system of innovation was immanent in the work of the IKE- group in Aalborg already in the first half of the 80s. A standard phrase found in several publications from this period was 'the innovative capability of the national system of production'. The 'innovation system'-concept was introduced in Lundvall (1985) but then still without the adjective 'national' added to it.

But the concept was immanent also in the international comparisons between national styles of management of innovation pursued at SPRU and it was Chris Freeman who brought the concept into the literature in 1987 in his book on innovation in Japan (Freeman 1987). And it was certainly immanent in the work of Dick Nelson and other US-scholars engaged in comparing the US system of science and technology with other national systems. When Freeman, Nelson and Lundvall got together in the big project on technical change and economic theory (Dosi et al, eds. 1988) it ended up with a book where there was a four chapter-section on 'national systems of innovation'.[1]

New models

One reason why the computer became much more widely diffused and used than originally expected was, of course, that the big mainframe models were substituted for by first mini- and later microcomputers. Many variations were developed on the

---

1 Others who worked in parallel along similar lines of thought but with less emphasis on innovation were Michael Porter (1990) and Richard Whitley (1994). Whitley's concept national business system is complementary to the innovation system approach in its emphasis on culturally embedded business practices. (For a comparison see Lundvall 1999).

basis of the original concept. A similar process has taken place in the context of innovation systems.

Over the last decade there have been several new concepts emphasizing the systemic characteristics of innovation but with focus on other levels of the economy than the nation state. The literature on 'regional systems of innovation' has grown rapidly since the beginning of the nineties (Cooke 1996; Maskell and Malmberg 1997). Bo Carlsson with colleagues from Sweden developed the concept 'technological systems (Carlsson and Jacobsson 1997) while Franco Malerba developed the concept of sectoral systems of innovation (Breschi and Malerba 1997).

Sometimes these concepts have been presented or interpreted as alternatives to the *national* system approach and it has been argued that many, if not most, interesting interactions in the context of modern innovation tend to cross national borders and that there is no a priori reason why the national level should be taken as a given for the analysis. Our view on the issue has always been pragmatic and reflects that we see the policy dimension of the concept as important. As long as nation states exist as political entities with their own agendas related to innovation, it is *useful* to work with *national* systems as analytical objects.

But the other analytical levels are certainly not only legitimate – they are necessary in order to get a realistic understanding of the working of national systems and, not least, the policy constraints and policy efficiency at the national level. They are also useful in their own right. Regional innovation policy calls for a focus on regional systems and understanding the evolution of global technological systems or sectoral systems is fundamental when it comes to define the needs for supranational co-ordination and rule-setting.

On the survival of old paradigms and on competing technologies

In the history of innovation there are many interesting cases where the old technology not only survives in parallel with the new one but also actually gets a new boost through the competition from it (Rosenberg 1982, p.114). An example in the computer field could be the efforts to increase the power of micro-computers as a response to the development of mini-computers.

The development of the systemic approach to innovation has taken place in parallel with efforts in economics to integrate knowledge and innovation into neo-classical growth theory as illustrated by the growing interest for 'new growth theory' (Romer 1990, Aghion and Howitt 1998). These models have big problems with overcoming the linear perspective and in policy analysis we still find a strong presence of the old ideas. The current focus in Europe on bench-marking innovation practices and policies may be seen as a step backwards in this respect (Lundvall and Tomlinson 2001). The old perspective is far from extinguished.

Development studies as a new field of application –or as a re-export

As pointed out, experts saw originally a very limited field of application for computers and this was the reason why they where modest when it came to forecast their diffusion. What has happened is an enormous extension of the use of computers to new fields of application in households, production and administration. The modern version of the concept of national systems of innovation was developed mainly in the rich countries – the US, the UK, France and Scandinavia – and to begin with only a narrow circle of academics interested in science and technology policy in these countries used it. Now the interest for the national innovation system perspective is growing strongly in Latin America and Asia. Even in Africa innovation system analysis is beginning to take off.

It is interesting to note that some of the most important elements combined into the innovation system concept actually came from the literature on developing countries. Hirschman (1958) and Stewart (1977), contributed with ideas of systemic feedbacks. The French structuralist school with ideas on national production systems – ideas that were applied mainly in some of the Mahgreb countries (Bernis 1966). Also, in economics the idea that institutions matter was more generally accepted for 'less developed countries' than for full blown market economies where it was assumed that the market solves most problems in a more or less institution-free world.

To apply the NSI-concept to developing countries may therefore be seen as a kind of 're-export'. Gunnar Myrdal's ideas, inspired from Veblen and fully developed in 'Asian Drama' (1968), of positive and negative feedback, of cumulative causation and of virtuous and vicious circles are inherent in the idea of innovation systems.

Adaptation of technology and concepts

It is well known that technology exported from the West does not always give rise to the expected benefits when introduced in the South. Computers without investments in infrastructure, trained personnel and organizational renewal may reduce rather than increase productivity.

At the end of this paper we will argue that a principal task for future research based on the NSI-concept is to adapt it in such a way that its application in less developed countries does not result in negative effects on development strategies and that it, on the contrary, helps to stimulate policy learning. We will argue that a major step in this direction is to broaden and deepen the concept and to make it more dynamic. A narrow focus on the role of science and science-based activities is not what is most needed. We need a concept that covers all aspects of competence building in socio-economic activities. We also need to deepen the concept by getting a better understanding of processes of interactive learning. Finally, we need to find ways to capture the formation and evolution of innovation systems from their birth to their death (Andersen and Lundvall 1997). In order to prepare the ground for such a broadening and deepening of the concept we will take a closer look at how the concept has developed in our own research.

The evolution of the Aalborg version of the NSI-concept

One of Schumpeter's major contributions to the understanding of innovation processes is the interpretation of innovation as *a new combination*. This concept is important because it brings together two contradictory but important aspects of innovation: its continuity (existing elements) and radical change (the new combination). It is obvious that the modern computer reflects a very complex combination of many different single technical breakthroughs in areas such as material technology, physics and software programming.

The Aalborg version of the national system of innovation concept may be seen as a combination of four elements: the French structuralist approach to national production systems, empirical work based on the Home market theory of international trade, the microeconomic approach to innovation as an interactive process inspired by research at SPRU and, finally, insights in the role of institutions in shaping innovative activities.[2] This combination reflects that the concept was developed to get a better understanding of economic growth and trade specialization in a small open economy characterized by high income per capita but with a weak representation of science based firms. The focus was to start with on macro-economic issues but it moved gradually also toward issues related to microeconomic dynamics.

From national systems of production toward national systems of innovation

Andersen brought to the IKE-group the inspiration from *the French structuralist economists*. In the 1960s and 1970s, they had developed an analysis of national systems of production that was rooted in the Marxian reproduction schemes. They assumed that different sectors affect growth differently and that the most dynamic elements in the system were located upstream. This led them into ordering national systems in a hierarchy. It was assumed that countries such as the US and Germany had a stronger economy than France because their production systems were specialized in the production of machinery to produce machinery (machine tools), while France was specialized in the production of machinery for the production of semi-manufactured goods (GRESI 1976). It also led them to recommend developing countries to establish, at an early stage, activities belonging to the sector producing machinery (Bernis 1966).

The basic mechanisms involved were not always made clear but the general idea was that the strong presence of a sector that produces machinery to produce machinery made it easier to develop and utilize new process technology for the production

---

2 This specific combination results in an Aalborg version that differs from the US-approach (Mowery and Oxley 1995) where the analysis is more narrowly focused on institutions as organizations involved in the promotion of science and technology. The combination should be seen in the light of our attempt to develop a framework that is relevant for understanding economic growth and innovation processes in small countries (Freeman and Lundvall 1998) and it may be seen as a follow-up to a series of contributions to the analysis of the specific problems of small countries (Katzenstein 1985, Kutznets 1960, Svennilsson 1960 and Walsh 1987).

system as a whole. Some economists tried to develop this approach further using Input-Output analysis (Brookfield 1975). Others applied a more dynamic approach to vertical linkages in the production system (Dahmén 1950, Hirschman 1958, Stewart 1977). Especially, Dahmén and Hirschman pointed to the opening up of disequilibria as important and sometimes positive drivers in the development process.

These different perspectives were brought together and combined with a life cycle perspective on national systems in a number of publications in Danish in the late 1970s (Andersen 1978, 1979). Some of the ideas were later presented for an international audience in Andersen and Lundvall (1988) and Andersen (1992). The French approach was significantly transformed in the process. First, the importance of backward linkages in the form of flows of information from user sectors was introduced. Second, both learning by doing and learning by searching were introduced in the model. Third, a distinction was made between industrial complexes at different stages as seen from a life cycle perspective. Fourth, the open economy was explicitly introduced as the analytical framework.

With these revisions, the focus was now explicitly on the development of new technology in an interaction between user sectors and producer sectors. The *quality* of demand became an important element in the process. And, while the approach of the French structuralist school left small countries very limited prospects in terms of growth and wealth, as does the new growth theory today, Andersen's revision pointed to a less gloomy future for these countries by emphasizing the *qualitative characteristics* of the home market.

The second element in the combination – the role of the home market for economic specialization

Some of the early empirical work in Aalborg focused on the Agro-industrial complex and one interesting result was the strong export specialization in machinery to be used in agriculture and related industries (Andersen et al 1981, p.11). This observation could not be explained without recourse to the role of the home market.

With reference to non-classical and non neo-classical contributions to international trade theory by Posner (1961), Vernon (1966) and especially Linder (1961) a series of empirical studies were pursued showing the importance of the home market when it comes to explain export specialization in process equipment (Dalum et al 1981; Andersen et al 1981). The practical test was to analyze the correlation between specialization indexes for respectively the user and the producer sector commodity. The outcome of the test was that the home-market did play an important role for many process equipment commodities.

In this context it was established that trade statistics offer good opportunities to characterize and compare the production structure and export specialization of national systems at a rather detailed level. If aggregated in new categories of special relevance for economic growth, specialization data could be used to analyze the competitiveness of national systems. The change over time in the specialization pattern in terms of 'low-

technology' versus 'high-technology'-product was later followed up by similar studies of high-growth and low-growth products. Further, analyzing the relative uniqueness and stability over time of specialization patterns proved to be a way to underpin the idea of national systems having a certain autonomy (Dalum et al 1998).

From Innovation as an Interactive Process to Innovation Systems

The micro assumptions behind the National Innovation System approach got theoretical inspiration from Nelson and Winter's evolutionary theory of firms and markets. Another important inspiration came from empirical findings through the 1970s and 1980s made by scholars connected to SPRU and Chris Freeman. The Sappho-study pursued by Freeman and his colleagues at SPRU in the beginning of the seventies (Rothwell 1977) gave strong support to the idea that success in innovation has to do with long-term relationships and close interaction with agents external to the firm. The presentation of "the chain-linked model", by Kline and Rosenberg (1986), was important because it gave specific form to an alternative to the cherished linear model, where new technology is assumed to develop directly on the basis of scientific efforts, and, thereafter, to be materialized in new marketed products. All this constituted one important step toward the idea of a National Innovation System and it indicated a possible micro-foundation of this concept.

The *second step* was to realize explicitly that the relationships and interactions between agents *had to involve non-price relationships*. These relationships were presented as *organized markets* with elements of power, trust and loyalty (Lundvall 1985). These relationships of co-ordination and co-operation were identified as the only possible solution to the conundrum of product innovations: On the one hand, pure market interactions (prices and quantities only) were found incapable of transmitting the qualitative information between users and producers. On the other hand, the transformation of markets into hierarchies proposed by transaction cost theory did not materialize. In order to understand the dynamics we proposed that the most fruitful perspective was to focus on *interactive learning* rather than on transactions.

The *third step* was to realize that different national contexts offer disparate possibilities for establishing organized markets. A series of studies pointed, for instance, to the long-term character of inter-firm relationships in Japan and contrasted them with the arm's length relationships predominating in the Anglo Saxon countries (Dore 1986, Sako 1990).

The fourth element in the combination - institutions and institutional economics

The focus on *interactive learning* evokes also the important role of institutions in determining the rate and direction of innovative activities. Early on Johnson (1988) insisted on the importance of institutions for innovation and learning processes. *Institutions* understood as norms, habits and rules are deeply ingrained in society and they play a major role in determining how people relate to each other and how they

learn and use their knowledge (Johnson, 1992). In an economy characterized by on-going innovation and fundamental uncertainty the institutional setting will have a major impact upon how economic agents behave and as well upon the conduct and performance of the system as a whole.

Which are the most important institutions in the context of innovation? We would like to sort out three institutional dimensions that have a major impact and which may differ across nations: the *time horizon* of agents, the role of *trust* and the *actual mix of rationality*.

The distinction between short-termism as characterizing corporate governance in Anglo Saxon countries and long-termism in for instance Japanese investment decisions is one important example of how institutional differences have a decisive influence on the conduct and performance at the national level. It is quite obvious that this distinction is important not only for the allocation of finance but also for other aspects of technical innovation. Certain technologies will only be developed by agents who operate with a long term perspective while others might be easier to exploit with a short term horizon.

Trust is a multidimensional and complex concept which refers to expectations about consistency in behavior, full revelation of what agents regard as relevant information for the other party and restraint in exploiting the temporary weakness of partners. The institutions that constitute trust are crucial for interactive learning and innovation capabilities. The strength and the kind of trust embedding markets will determine to what degree interactive learning can take place in connection in organized markets. Formal and legal arrangements around the market will reflect and have an impact upon this tacit social dimension.

A third category is the pre-dominating rationality. In standard economics it is assumed that instrumental and strategic rationality is dominating human behavior at least in the private economic sphere. It is correct that economic transactions between anonymous agents and a capitalist environment tend to support instrumental rationality. In a context where learning new skills through interaction with other agents is important for success, it is, however, no longer the only kind of behavior that might be selected in the evolving economy. If instrumental rationality were completely dominating the interaction between professors and students, masters and apprenticeships as well as between engineers from R&D- labs belonging to different firms, very little learning would take place. Therefore innovation systems where communicative rationality (Habermas, 1984) played a major role in certain types of activities in the private sector might be better off in the long run than the standard exchange economy. The actual mix of rationality in an innovation system may affect its conduct and performance.

In addition to these informal institutions a number of formal institutional arrangements, like well defined and implemented property rights of different kinds, including intellectual property rights, contract laws, corporate law, arbitration

institutions and collective bargaining and other labor market institutions, are of course also important for the working of the economy and more generally recognized as such.

In general we find it useful to think about innovation systems in two dimensions. One refers to the structure of the system – what is produced in the system and what competences are most developed? The second refers to the institutional set up – how does production, innovation and learning take place? Historical analysis may be helpful in demonstrating how the two dimensions co-evolve. Is it the evolution of the structure of production that determines the evolution of the institutional set-up or vice versa and how is match and mismatch between the two reflected in economic growth patterns (Freeman 1995b)?

On the need to focus on the national system for knowledge creation and learning

We see three major challenges for innovation system studies. The most important is to focus the analysis much more strongly on the process of learning and competence building. A second challenge is to build into the concept a more dynamic dimension that relates to the creation, transformation and passing away of innovation systems. The third one has to do with the need to broaden the analysis of economic development and to study how knowledge production is conditioned by and affects social and ecological sustainability.

Innovation systems in the learning economy

In a series of papers we have argued that the last decades have been characterized by a new context that we have baptized 'the learning economy' (Lundvall and Johnsson 1994, Archibugi and Lundvall 2001). The new context is more than anything else characterized by a speed up in the rate of change giving a stronger importance to learning processes for economic performance. This is why we argue that today the most important elements in innovation systems have to do with the learning capability of individuals, organizations and regions. The very rapid rate of change gives a premium to those who are rapid learners. This is reflected in the forms of organization inside firms, new mixtures between co-operation and competition as well as in new forms of governance. It presents all organizations and especially those specialized in the production, diffusion and use of knowledge for new challenges.

So far, the studies of national systems of innovation have given too little emphasis to the subsystem related to human resource development.[3] This includes the formal education and training, the labor market dynamics and the organization of knowledge creation and learning within firms and in networks. This subsystem will be confronted with very

[3] An exception is Amable, Barré and Boyer (1997) where the labour market and training systems are integrated in the analysis of what they call 'social systems of innovation'.

strong needs for social invention in the near future in all national systems and quite a lot of the peculiarities of national systems are rooted in this sub-system.

Another new focus must be on the part of business services that specializes in producing, gathering and selling knowledge. This sector is growing more rapidly than any other sector and new empirical studies indicate that it is becoming a key sector in the French structural school sense (Tomlinson 2001). More and more producers of tangible products and traditional services move into this field. To understand how such businesses operate within and across national borders is another key to understanding the future economic dynamics.

The production and diffusion of knowledge is itself changing character. Some elements of knowledge become codified and much more mobile globally while other key elements remain tacit and deeply embedded in individuals and organizations and localities. To understand better these processes may, actually, be a key to establish a new kind of economy (OECD 2000). This points to an ambitious theoretical research agenda aiming at understanding processes of learning in the context of production and innovation systems. It has been argued by Marx that what really made the industrial revolution a revolution was not the use of machinery but rather the stage where machinery was used to produce machinery. It may be the case that it is only when we systematically can apply knowledge to the production of knowledge that we will witness the establishment of the learning economy.

To understand the process of transformation, it is useful to analyse and understand how specific national systems respond to global trends and challenges. Some national systems may, for historical reasons, be better prepared to cope with the new context than others. Some systems may be more innovative than others when it comes to develop policy strategies and institutional reforms that respond to the new challenges. The *Danish system of innovation and competence building* is small in global terms but it has certain characteristics that might make it interesting as one possible 'model' for international institutional learning.[4] It is one of the most egalitarian societies in the world in terms of income distribution and at the same time it has an income level that is among the highest in the world. It has a high degree of gender equality and well-developed local democracy.

[4] It is interesting to note that the on-going OECD-project on economic growth in the context of 'the new economy' Denmark, Norway, Finland and other small egalitarian societies appear together with the US as the success stories. Also it is concluded that there is no simple relationship between inequality and economic growth.

Characterizing the Danish system in terms of innovation

Denmark is specialized in low technology products and in sectors characterized by small firm size

It is a fact that Danish export and production is strongly specialized in low-technology products. We find a low technology-specialization in several other small high-income countries but Denmark stands out as extreme also among those.

Box 1: Personalities and innovation systems

The Danish system of innovation and competence building is not the outcome of a planned political effort. Its strengths and weaknesses reflect unintended consequences of pragmatic policy, the impact of unique personalities and small historical events. One way to illustrate this is to refer to two individuals who each in his way shaped the Danish innovation system. It may be argued that the peculiar mix found in the Danish innovation and competence building system of a predominating experience-based production and a small high technology sector reflects the influence of respectively Grundtvig and Ørsted, with Grundtvig as the one with the biggest impact.

Grundtvig – the provincial priest

In the second half of the nineteenth century the Danish society went through a dramatic transformation. 1864 was a crucial year because it marked the loss of German speaking regions and the end of any ambitions toward colonial power. At this occasion a slogan was coined – 'what has been lost externally must be regained internally'.

The last decades of the century was marked by a deep agricultural crisis where the traditional export markets for vegetable products where crumbling. The production had to be changed toward animal products. This dramatic transformation was to a high degree self-organized through collaboration between small independent farmers. It found its ideological support in the ideas of the popular priest Grundtvig. Grundtvig initiated the 'folkhøjskole' (a school open to adults and aiming at general education but without exams or grading - organized locally but with the support from the state). The main objective was to educate farmers and to give them self-confidence. One major outcome was the formation of strong democratic and decentralized producer co-operatives in dairy and meat production – the dominating export goods at the time.

This peculiar period of Danish history is important to understand some of the current characteristics of the Danish innovation and competence building system. It is reflected in the industrial structure as well as in the mode of innovation. The fact that the most important export products – dairy and meat products – remained under the control of farmer co-operatives explains why the basis for establishing big privately owned export oriented firms was much weaker in Denmark than in Sweden. The high regard of decentralized general education and of learning in Denmark was established in this period and is still reflected in the organization of continuous education where the state supports local initiatives.

Ørsted – the Copenhagen scientist

There is a proverb in Denmark that Jutland, the big rural peninsula where Grundtvig spent most of his life, is 'far from Copenhagen'. At the end of the nineteenth century, Copenhagen was still a small city with a small highly interactive intellectual elite. Among the elite the mathematician and physicist Ørsted, after academic struggles, became the founder of the Polytechnic University in Copenhagen. He succeeded in giving this institution a highly academic profile with a strong emphasis on natural science. Practical engineering disciplines were not appreciated (Wagner 1999).

When the very interactive Danish firms interact less with universities than firms do in other countries there are two factors at play. One is, certainly, that Danish firms are small and operate in low technology areas. But the other one may be that the technical university was founded by a natural scientist. This last interpretation is compatible with the fact that the strong science-based sector in Denmark – pharmaceuticals – actually seems to have stronger roots in science than firms in this sector have in other countries.

There are some high technology islands in the Danish economy and especially the sector producing pharmaceuticals (dominated by NOVO-Nordisk) is extreme in its strong connection to science. This has resulted in misinterpretations of Danish innovation as more strongly science based than in other countries (OECD 2000). Denmark is especially successful in the production and export of 'low' and 'low medium' technology goods. This includes food products, furniture and clothing. Besides it has successful niche products in telecommunication (mobile communication) and in process regulation (Danfoss). Within all these fields firms are quite successful in absorbing and using technology from abroad including information technology. Incremental product development characterizes both the high technology and the low technology firms.

The mode of innovation is highly interactive but not science based

Within firms there is a growing emphasis on the interaction across departments, between colleagues and between management and workers. Danish manufacturing firms interact with customers and suppliers more frequently than firms in other countries. The growth in the interaction takes place in relation both to Danish and foreign parties.

On the other hand, the interaction with universities is less developed in Denmark than abroad. To a certain degree this reflects a rather well functioning system of technological institutes that communicate new technological insights to the firms. But it is also true that the university system historically has been strongly geared toward the needs of the public sector both regarding education and research. Research policy in Denmark has been designed in collaboration with a handful of experts working in the most strongly science-based firms who, referring to their own experience, have seen few problems in the interaction between industry and universities.

The use of human resources is biased in favor of the public sector

Historically most of the academically trained work force has been employed in the public sector. This has gradually been changing through the last decade where especially business services have absorbed a growing proportion of the candidates. But still a big proportion of private firms have no academics in their workforce. We can show that firms belonging to this group collaborate much less with universities than those that have engineers and other employees with academic training on their staff. Most of the innovation activities in the first group are either experience-based and incremental or coming from suppliers, including knowledge intensive business services.

Characterizing the system in terms of knowledge management

One reason why it is difficult to change the pattern of specialization in the direction of science based and high technology products is that the Danish pattern of human resource development tends to support the established mode of innovation in a systemic way. The Danish human resource development system (the school system, vocational training and the efforts made by firms to develop the skills of their employees) is quite unique. And, in certain respects, it matches quite well the Danish incremental approach to innovation in

low and medium technology sectors. Therefore, an upgrading and a stronger emphasis on formal (as contrasted to practical experience based knowledge) knowledge in the production system must be combined with changes in education and training.

The Danish education system fosters independent and responsible workers with weak formal competencies

Young people are expected to be independent and responsible in Denmark. International studies show that they use little time on homework but a lot of time on small jobs to get their own income. When finished with high school they take a year off and work or go abroad before taking a higher education. They rate quite weakly (the extent and causes are still under debate among educationalists) in international tests on skills in reading and mathematics, at least in the earlier school years. But they seem to be extremely well prepared for working in a turbulent economy where there is a need to delegate responsibility to the lower levels in the organisation. They are used to communicate directly and freely also with authorities (teachers and employers).

The Danish labor market gives weak incentives to firms for investing in training

The Danish labour market is characterized by high mobility between firms (as high or higher than in the US) but a more limited geographical mobility. Danish firms invest less in training their own personnel than firms in other countries. On the other hand, the public sector has built a unique and quite comprehensive and costly system for continuous education. This means that Danish workers on average get more time for training within a year than workers in other countries. Firms contribute through a wage tax to the finance of the public training and tripartite bodies representing labour, industry and the public sector at the regional level organize an important part of it. This specific division of labour between the private and the public sector reflects among other things the fact that there are many small firms in the Danish economy that could not take on the responsibility for training their employees on their own. But it has also resulted in bigger firms using fewer resources on internal training and developing explicit human resource development strategies to a lesser degree than their foreign counter-parts.

The Danish labor market is flexible and efficient but it is also characterized by polarization to the disadvantage of unskilled and foreign workers in terms of job opportunities

There are a number of unique features of the labour market that needs to be taken into account when considering the working of the over all innovation system. The substitution rate of unemployment support is higher and support is less restricted in time than in other OECD-countries and this fact explains many of the peculiarities. It is one factor behind the high participation rates and it also explains the fact that workers in Denmark feel more secure in their jobs than their colleagues in other European countries with stronger legal protection from firing and with less mobility. High mobility reflects to a certain degree that employers meet almost no legal restrictions when it comes to firing personnel. But it also reflects that workers at all skill levels are less afraid of getting lost between

different jobs when looking for new job opportunities. OECD and labour market economists have emphasised the negative impact on job incentives but an 'irrational' willingness to work seems in many cases to overcome this negative incentive. Among women, for instance, 20-30% work for a wage in spite of the fact that economically they could be as well or better off staying at home. The Danish labour market is performing well also in terms of low and falling rates of respectively structural, long term and youth unemployment.

Box 1: Six lessons from the DISKO study

Lesson no 1, On the compatibility of equality and growth: The Danish economy is one of the most egalitarian in the world in terms of income distribution and it is among the ones with the highest GNP/capita. The growth success of the US has gone hand in hand with increasing inequality. The experience of Denmark demonstrates that there is no necessary connection between strong growth and growing inequality.

Lesson no 2, On the compatibility of flexibility and security in the labour market: In international organisations such as OECD there has been a general message to increase flexibility in labour markets. Trade unions have opposed and pointed to the need for security. The Danish data show that the forms of flexibility that are most adequate in the learning economy are compatible with security among wage earners. High mobility between employers has not resulted in insecurity among employees because the social security provision has been acceptable. In Denmark, the introduction of functional flexibility within firms tends to reduce the need for numerical flexibility.

Lesson no 3, On the importance of innovation in low technology sectors*:* One of the interesting aspects of the Danish system is that its relative wealth has been built in spite of a specialization in low technology sectors and that most of its innovations are incremental and experience-based rather than radical and science based. Supporting innovation in low technology areas will remain an important priority for industrial policy. In the light of the 'new economy'-discourse there might be a risk to forget about the renewal of competence in traditional sectors, including service sectors.

Lesson no 4, People and career patterns matter for the formation of networks: The Danish economy is characterised by intense interaction between firms while the interaction between firms and universities is weakly developed. As demonstrated in this study this characteristic reflects the composition of the labour force in firms and the absence of academic personnel in many small and medium-sized firms. A general conclusion is that network formation and establishing new linkages may best be established by affecting career patterns and incentive systems in firms and at universities.

Lesson no 5, What matters most is learning to learn and learning organizations: The rapid rate of change undermines established competence and requires the continuing establishment of new ones. Firms that become learning organisations are more productive and more innovative. They create more and more stable jobs. Much of the resistance is found at the top rather than at the bottom of the organisation. Promoting organisational change is becoming a crucial element of innovation policy. Education and training institutions need to focus on learning students to learn.

Lesson no 6, Social capital matters for growth and the need for a new new deal: The only way to explain the strong economic performance of Denmark and other small economies with a weak specialisation in high technology products is to take into account the social capital that makes it easier for people to learn, collaborate and trade. The most important threat to this mode of production and innovation is the growing polarisation and exclusion of those who do not fit into the learning economy. To give those a stronger learning capability and access to the networks where learning takes place is crucial for the sustainability of the learning economy.

There is one area where it does not fare as well, however. Unskilled workers and workers with a different ethnical background are much worse off than the rest of the labour force in terms of job opportunities and employment. Here Denmark is performing worse than most other OECD-countries. DISKO-data also show that the training initiatives inside firms tend to reinforce the polarization. The chance for unskilled workers to get training in house in firms is much less than for other categories of employees.

Innovation systems and economic development

As mentioned above the concept of innovation systems has mostly been applied to problems of growth and development in the high-income countries of the North. However, it is our contention that it is relevant also for the South.There are different conceptualizations of innovation systems but when explicitly focusing on the South the broad approach applied in the DISKO-project is to be preferred. Here, innovations are seen as rooted in everyday activities in firms and in the competencies and capabilities of ordinary of people.

Innovation systems work through the introduction of knowledge into the economy (and into the society at large). It requires active learning by individuals and organizations taking part in processes of innovation of different kinds. The efficiency of these learning activities and, hence, the performance of the innovation systems depends of economic, political and social infrastructures and institutions. It also depends on past experiences as they are reflected in the tangible and intangible aspects of the structure of production and on values and policies. The learning capabilities, which are instrumental in the innovation process, are also values in their own respect. This is also the case for possibilities for education and participation in democratic processes. In fact many of the factors that make people effective learners may be viewed also as constitutive parts of development.

It follows that there are good reasons for using a broad concept of innovation system in connection to development analysis both when focusing on countries in the North and in the South. However, the reasons seem to be strongest for the South. A narrow innovation system concept focusing on the research and development system and on high tech and science-based innovations seems to us to make even less sense in the South. There are several reasons for this.

In a relatively ‘complete’ national system of innovation it may be less problematic to analyze a specific subsystem. If there are adequate knowledge infrastructures and intellectual property rights and if there are good networking capabilities and high levels of trust, there is also a suitable basis for an efficient research and development system. It may then be quite possible to analyze the details of this subsystem without worrying too much about the rest of the innovation system. But this is typically not the case in the South, which makes a broad approach preferable.

Another reason is that the need to take into account local and traditional knowledge may be relatively bigger in the South than in the North. The broader approach pays attention to tacit knowledge (Polanyi 1958; Polanyi 1966) and to the need not to loose important parts

of largely not codified and undocumented local competencies. Local knowledge is easily de-learnt and forgotten when economies are opened up to international competition and societies accordingly restructured. A broad concept of innovation systems helps to see the importance of different kinds of knowledge and the ways they complement each other (Ernst and Lundvall 1997).

The often very uneven distribution of both constitutive and instrumental freedoms in the South makes it important not to focus only on the relatively strong and internationally competitive parts of the economy. Also for this reason a broad innovation systems approach should be endorsed.

Weaknesses of the innovation system approach

When applied to countries in the South it is important to be aware of some weaknesses of the innovation system approach, as it has been used so far. Some of these have directly to do with the fact that it has mostly been applied to the North. It has been used mainly as an ex-post rather than as an ex-ante concept (Arocena and Sutz 2000). It has been used to describe, analyze and compare relatively strong and diversified systems with well developed institutional and infrastructure support of innovation activities. It has not, to the same extent, been applied to system building. When applied the South the focus ought to be shifted in the direction of system construction and system promotion. Furthermore, the relationships between globalization and national/local systems need to be further researched. It important to know more about how globalization processes affect the possibilities to build systems of innovation in developing countries and local systems are important parts of this.

Another weakness of the system of innovation approach, is that it is still lacking in its treatment of the power aspects of development. The focus on interactive learning – a process in which agents communicate and even cooperate in the creation and utilization of new economically useful knowledge – may lead to an underestimation of the conflicts over income and power, which are also connected to the innovation process. Interactive learning and innovation immediately sounds like a purely positive sum game, in which everybody may gain. In fact, there is little learning without forgetting. Skills and competencies are rejected and destroyed and many people experience decreasing income and influence. Increasing rates of learning and innovation may lead not only to increasing productivity and income but also to increasing polarization in terms of incomes and employment. It may be more common in the south than in the north that interactive learning possibilities are blocked and existing competences destroyed (or de-learnt) for political reasons related to the distribution of power.

It is true that it does not have to be like that. Different types of (integrated) policies might counteract the tendency. But the tendency is, certainly, inherent in the learning economy and counteracting policies are in more short supply in the South than in the North. Furthermore, a certain amount of stability in the macroeconomic and financial environment, including well behaved, not too conflict provoking, fiscal and monetary

policies, is important for interactive learning and innovation. Again, such stability is typically lacking in developing countries.

It is thus, clear that the innovation system approach needs to be adapted to the situation in developing countries if it is to be allied to system building. It seems also clear, however, that the holistic and systemic character of the approach and its focus on production based tacit knowledge and on learning by doing, using and interacting should make it possible to implement such adaptations.

A broader perspective on economic growth and development

National Systems of Innovation may be regarded as a tool for analyzing economic development and economic growth. It has in common with growth accounting that it tries to bring together the major factors that affect technical progress as registered in standard neo-classical growth models. Such a perspective may be to narrow, however. As pointed out by Freeman (1997) the ecological challenge ought to be integrated in any strategy for economic development and here we will argue that in the learning economy intellectual and social capital are important elements in the development process. The extended perspective can be introduced as in table 2 below[5]:

Table 1: Resources fundamental for economic growth – combining the tangible and reproducible dimensions

	Easily reproducible resources	Less reproducible resources
Tangible resources	1. Production capital	2. Natural capital
Intangible resources	3. Intellectual capital	4. Social capital

The table illustrates that economic growth is faced with a double challenge in terms of sustainability and that there is an immanent risk of undermining not only the material basis of material production. The creation of tangible capital may be threatened by a neglect of environmental sustainability. We will argue that the production and efficient use of intellectual capital is fundamentally depending upon social capital (Coleman 1990; Fukyuama 1995; Woolcock 1998). A development strategy that focuses only on production capital and intellectual capital is not sustainable.

Innovation may have a positive role in bolstering sustainability (Johnson 1998). Technical innovation, for instance in terms of developing substitutes to naturally scarce raw products, may help to overcome the fact that natural capital cannot always be reproduced.

---

5 The 'model' indicated in the table is closely related to the growth model by Irma Adelman (1963) to be discussed below. The major difference is that labour is not explicitly introduced in our table. This reflects that we do not regard labour as a resource of the same character as the four kinds of 'capital'. The human factor is the one that puts in motion, integrates and co-ordinates the different kinds of capital.

In a similar vein social innovation and institutional redesign may help to overcome a crisis where the social capital is foundering. In both cases it is important to note that the workings of unhampered market forces will erode the basis of economic growth. Environmental sustainability was explicitly introduced into a national innovation system approach by Segura-Bonilla (1999).

This perspective indicates a broader and more interdisciplinary approach to economic growth than standard economics. It also differs in being more explicit in terms of the institutional assumptions made and especially in avoiding any assumption about factors being independent. This reflects the system's perspective and the emphasis on virtuous and vicious circles or match and mismatch between elements and subsystems. Some of the most fundamental contradictions in the new context can also be referred to in terms of problems to reproduce natural and social capital.[6]

Contradictions in the learning economy

In the present era of the globalizing learning economy (Lundvall and Borras 1998) there are *contradictions* inherent in the economic process that threaten learning and competence building by undermining social capital. Financial speculation seems to become more and more unhampered and increasingly it is finance capital that judges what is ‘good-practice’ among firms as well as among governments. This power of financial capital is one of the major factors that speed up the rate of change and thereby the need for accelerating learning. At the same time the uninhibited rule of finance capital gets into serious conflict with some of the fundamental prerequisites for the sustainability of the learning economy. It is a fundamental contradiction that financial capital that is ‘silly capital’ dominates an economy based upon learning and knowledge.

On the one hand short-term economic calculations and speedy processes of decision-making (especially in financial flows) are getting more and more important (Jessop, 1999). On the other hand competition depends more and more on dynamic efficiency rooted in knowledge or knowledge related resources with long-term characteristics. These resources often take a long time and sustained efforts to build but they may also be quickly destroyed. This is because learning and innovation are interactive processes, which depend on trust and other elements of social cohesion.

One problem is that the speed-up of change puts a pressure on all kinds of established social relationships in local, regional and national communities. It contributes to the weakening of traditional family relationships, local communities and stable workplaces. This is important since the production of intellectual capital (learning) is strongly dependent on social capital. To find ways of re-establishing the social capital undermined by the globalization process is a major challenge.

---

6 The manifold use of the concept of capital may be criticized. An alternative view could be that the confusion in economics about different meanings of capital is already such that it is as well to loosen up the concept even more in order to split the illusion that capital has a clear meaning in economics.

Another problem is that the short term perspectives promoted by financial capital give little weight to long term ecological imbalances. The discount rates are very high not only when it comes to assess future benefits but also when it comes to assess ecological costs. Natural capital including unpolluted air in the big cities and clean drinking water is not sufficiently valued in a regime dominated by a governance form where finance capital is directly or indirectly in charge.

These contradictions in the learning economy increase the need for policy co-ordination. Below we will argue that there is a need for policy learning in terms of building new kinds of institutions for policy co-ordination. Such institutions would have as strategic responsibilities to develop a common vision for how to cope with the challenges and contradictions of the globalizing learning economy. At the national level such a vision has to be based on a deep understanding of the distinct national system of competence building and innovation on the one hand and of the major trends in the global context on the other.

Innovation policy

When it comes to supporting innovation processes through different kinds of policy there is a growing consensus on the need to focus on long term competence building in firms and in society as a whole. At the same time, the prevailing institutional set up and global competition tends to give predominance to short term financial objectives in policy making. At the institutional level this is reflected in the fact that ministries of finance have become the only agency taking on a responsibility for coordinating the many specialized area policies. Area specific ministries tend to identify with their own ’customers’ and take little interest in the wider objectives of society.

A broad concept of innovation system implies a new perspective on a wide set of policies including social policy, labour market policy, education policy, industrial policy, energy policy, environmental policy and science and technology policy. Specifically, the concept calls for new national development strategies with co-ordination across these policy areas.

All these area specific policies affect learning and competence building. They need to be designed with this in mind and brought together and attuned into a common strategy. It is highly problematic to leave policy co-ordination exclusively to ministries of finance and to central banks since their visions of the world are necessarily biased toward the monetary dimension of the economy and thereby toward the short term. The analytical efforts aiming at increasing our understanding of the regional, national and transnational innovation systems need to be supported by new policy institutions in the form of high level councils for innovation and competence building at these levels. Such councils should be given authority to take into account issues of social and ecological sustainability and the power to counter short term views of finance capital.

Another important potential of applying the innovation system concept and to pursue comparative studies of different systems is that it helps to get a critical understanding of the limits of specific national policy strategies. Policies aiming at promoting industrial

development through innovation will often tend to follow specific trajectories and often they will be more successful in reinforcing the system where it is already strong. This was our conclusion in Edquist and Lundvall (1993) where we found that Swedish policies were focused on promoting process innovation while Danish policies where more focused on incremental product innovation. In both countries the focus was on reinforcing the strong sides of the system. In order to overcome this kind of lock ins and the impact of vested interests in defining the policy agenda the system perspective and its use in comparative analysis is especially helpful.

Concluding remarks

We believe that the broad concept of national system of innovation may be useful as an analytical tool and as a tool for promoting sustainable economic growth and well-being also in countries in the South. At the same time, we recognize the need to adapt and further develop the concept so that it becomes more adequate for the situation in these countries.

On the positive side it points to a legitimate national mobilization of efforts and to a co-ordinated policy effort to enhance learning capabilities necessary in order to get started a new type of dynamics in these countries. In order to do so it needs to inspire activities that mobilize broadly across sectors and regions.

On the negative side there is always a risk that the concept becomes misinterpreted as a basis for promoting exclusive science-based institutions and activities with very limited socio-economic impact. There is a need for broad efforts to promote the learning capability including that of weak segments of the population and of the country.

Also analytical efforts to better understand how more complete innovation and competence building systems may be constructed in the present environment of global competition and networking need to be made. The power games of exclusion and inclusion in relation to global knowledge-intensive networks has become of key importance for development.

References

Adelman, I. (1963), Theories of Economic Growth and Development, Stanford, Stanford University Press.

Amable, B., Barré, R. and Boyer, R. *et al*. (1997), *Les systémes d'innovation a l'ére de la globalization*, Paris, Economica.

Aghion, P. and Howitt P. (1998), *Endogenous Growth Theory*, Cambridge Mass. MIT Press.

Andersen, E.S (1978), Industriel udvikling og industrikrise, Serie om industriel udvikling no. 4, Aalborg, Aalborg Universitetsforlag.

Andersen, E.S. (1979), Industriel udvikling og international konkurrenceevne, Serie om industriel udvikling no. 6, Aalborg, Aalborg Universitetsforlag.

Anderson E. S., Dalum, B. and Willumsen, G. (1981), International Specialisation and the Home Market – an empirical analysis, aalborg, Aalborg University Press.

Andersen, E.S. (1992), 'Approaching National Innovation Systems', in Lundvall, B.-Å. (ed.), National Innovation Systems, London, Pinter Publishers.

Andersen, E.S. and Lundvall, B.-Å. (1988), 'Small National Innovation Systems Facing Technological Revolutions: An Analytical Framework', in Freeman, C. and Lundval, B.-Å. *Small Countries Facing the Technological Revolution*, London, Pinter Publishers.

Andersen, E.S. and Lundvall, B.-Å. (1997), 'National innovation systems and the dynamics of the division of labor', in Edquist, C. (ed.), *Systems of innovation: Technologies, institutions and organizations*, London, Pinter Publishers.

Archibugi, D. and Pianta, M. (1992), *The technological specialization of advanced countries*, Dordrecht, Kluwer Academic Publishers.

Archibugi, D. and Michie, J. (1995), 'The globalization of technology: a new taxonomy', in *Cambridge Journal of Economics*, 19:1.

Archibugi, D. and Lundvall, B.-Å. (eds.) (2001), *Europe in the Globalising Learning Economy*, Oxford University Press.

Bernis, G.D de (1966), 'Industries industrialisantes et contenu d´une politique d´integration régionale', *Economic Appliquée*.

Bertalanffy, L. (1968), *General system theory*, New York, George Braziller.

Breschi, S. and Malerba, F. (1997), 'Sectoral innovation systems', Edquist, C. (ed.), *Systems of innovation: Technologies, institutions and organizations*, London, Pinter Publishers.

Brookfield, H. (1975): *Interdependent Development. Perspectives on Development*, London: Methuen.

Cantwell, J.A. (1995), 'The globalization of technology: What remains of the product cycle model?', in *Cambridge Journal of Economics*, vol. 19, no. 1.

Carlsson, B. and Jacobsson, S. (1997), 'Diversity creation and technological systems: A technology policy perspective', in Edquist, C. (ed.), *Systems of innovation: Technologies, institutions and organizations*, London, Pinter Publishers.

Castells, M. (1997), *The Rise of the Network Society*, Maldon Mass. and Oxford, Blackwell.

Coleman J. (1990), *Foundations of Social Theory*, London: Harvard University Press.

Cooke, P. (1996), 'Regional innovation systems: An evolutionary approach', in Baraczyk, H., P. Cooke and R. Heidenriech (eds.), *Regional innovation systems*, London, London University Press,

Dahmén, E. (1950): Svensk industriell företagarverksamhet. Kausalanalys av den industriella utvecklingen 1919-1939, Lund: Industriens Utredningsinstitut.

Dalum, B. et al (1981), Økonomiers langsigtede udvikling – en struktur og teknologidiskussion (On the long term development of the economy – structural and technological change, Aalborg.

Dalum, B., Laursen, K. and Willumsen, G. (1998), "Structural Change in OECD Specialisation Patterns: Specialisation and 'Stickiness'", International Review of Applied Economics, Vol 12, No 3.

Dore, R. (1986*), Flexible rigidities: Industrial policy and structural adjustment in the Japanese economy 1970-1980*, London, Athlone Press.

Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G. and Soete, L., (eds.), *Technology and economic theory*, London, Pinter Publishers.

Edquist, C. (ed.) (1997), *Systems of innovation: Technologies, institutions and organizations*, London, Pinter Publishers.

Edquist, C. and Lundvall, B.-Å. (1993), 'Comparing the Danish and Swedish Systems of Innovation', with C. Edquist, in Nelson, R.R. (ed.), *National Innovation Systems: A Comparative Analysis*, Oxford, Oxford University Press.

Ernst, D. and Lundvall, B.-Å. (1997), 'Information technology in the learning economy – challenges for developing countries', *DRUID Working Paper 97-11*, Aalborg, Department of Business Studies.

Fransman, M. (1995), Japan's computer and communications industry, New York, Oxford University Press.

Freeman, C. (1987), *Technology policy and economic performance: Lessons from Japan*, London, Pinter Publishers.

Freeman, C. (1988), 'Japan: A new National Innovation Systems?', in Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G. and Soete, L.,(eds.), *Technology and economic theory*, London, Pinter Publishers.

Freeman, C. (1995a), 'The National Innovation Systems in historical perspective', in *Cambridge Journal of Economics*, vol. 19, no. 1.

Freeman, C. (1995b), 'History, co-evolution and economic growth', in *IASA Working Paper 95-76*, Laxenburg, IASA.

Freeman, C. (1997), *Innovation systems: City-state, national, continental and sub-national*, Mimeo, Paper presented at the Montevideo conference, University of Sussex, SPRU.

Freeman, C. and Lundvall, B.-Å. (eds) (1988) *Small Countries Facing the Technological Revolution*, London: Pinter Publishers.

Fukyama, F. (1995), *Trust: The social virtues and the creation of prosperity*, London, Hamish Hamilton.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P. and Troiw, M. (1994), *The New Production of Knowledge*, Sage, London.

GRESI (1976) (Groupe de reflexion pour les strategies industrielles), *La Division internationale du travail*, Vol. I-II, Paris.

Guerreri, P. and Tylecote, A. (1997) 'Interindustry differences in technical change and national patterns of technological accumulation' in Edquist, C. (ed.), *Systems of innovation: Technologies, institutions and organizations*, London, , Pinter Publishers.

Habermas, J. (1984), *The Theory of Communicative Action*, Vol. I, Boston, Beacon Press.

Hirschman, A.O. (1958), *The strategy of economic development*, Clinton Mass.: Yale University Press.

Jessop, B.(1999), 'The state and the Contadictions of the Knowledge-Driven Economy', *Development Research Working Papers*, Department for Development and Planning.

Johnson, B. (1988), 'An Institutional Approach to the Small Country Problem' in Freeman and Lundvall (eds*), Small Countries Facing the Technological Revolution, London and New York*, Pinter Publishers

Johnson, B. (1992), 'Institutional learning', in Lundvall, B.-Å. (ed.), *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers.

Johnson, B. (1998), 'Institutional Learning and Clean Growth' in Tylecote A. and van der Straaten,J. (eds) *Environment, Technology and Economic Growth*, Edward Elgar Publishing Limited.

Katzenstein, P. J. (1985) *Small States in World Markets. Industrial Policy in Europe*, New York: Cornell University Press.

Kline, S. J. and Rosenberg, N. (1986), 'An overview of innovation', in Landau, R. and Rosenberg, N. (eds.), *The positive sum game*, Washington D.C., National Academy Press.

Kutznets, S. (1960), 'Economic Growth of Small Nations', in Robinson, E.A.G. (ed.), *Economic Consequences of the Size of Nations*, Proceedings of a Conference held by the International Economic Association, Macmillan, London.

Linder, S.B. (1961), *An Essay on Trade and Transformation*, New York, Wiley.

List, F. (1841): *Das Nationale System der Politischen Ökonomie*, Basel: Kyklos (translated and published under the title: The National System of Political Economy' by Longmans, Green and Co., London 1841).

Lundvall, B.-Å. (1985), *Product Innovation and User-Producer Interaction*, Aalborg, Aalborg University Press.

Lundvall, B.-Å. (1988), 'Innovation as an interactive process: From user-producer interaction to the National Innovation Systems', in Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G. and Soete, L.,(eds.), *Technology and economic theory*, London, Pinter Publishers.

Lundvall, B.-Å. (ed.) (1992), *National Innovation Systems: Towards a Theory of Innovation and Interactive Learning*, London, Pinter Publishers.

Lundvall, B.-Å. and Johnson, B. (1994), 'The learning economy', *Journal of Industry Studies*, Vol. 1, No. 2, December 1994, pp. 23-42.

Lundvall, B.-Å. (1999) 'National Business Systems and National Innovation Systems' *International Studies of Management and Organization* (forthcoming)

Lundvall, B.-Å. and Borras, S. (1998*), The globalising learning economy: Implications for innovation policy*, Bruxelles, *DG* XII-TSER, the European Commission.

Lundvall, B.-Å. and M. Tomlinson (2001), 'Learning by comparing: Reflection on the use and abuse of benchmarking', in Sweeney, G. (ed.), Innovation, Economic Progress and Quality of Life, London: Elgar Publishers.

Maskell, P., Eskelinen, H., Hannibalsson, I., Malmberg, A. and Vatne, E. (1998): *Competitiveness, localised learning and regional development. Specialisation and prosperity in small open economies.* London: Routledge.

McKelvey, M. (1991), 'How do National Innovation Systems differ?: A critical analysis of Porter, Freeman, Lundvall and Nelson', in Hodgson, G. M. and Screpanti, E. (eds.), *Rethinking economics: Markets, technology and economic evolution*, Aldershot, Elgar Publishing House.

McKelvey, M. (1997), Using evolutionary theory to define National Innovation Systems, in Edquist, C. (ed.), *Systems of innovation: Technologies, institutions and organizations*, London, Pinter Publishers.

Mowery, D.C. and Oxley, J.E. (1995), 'Inward technology transfer and competitiveness: the role of National Innovation Systems', in *Cambridge Journal of Economics*, vol. 19, no. 1.

Myrdal, G. (1968), *Asian Drama; An Inquiry into the Poverty of Nations*, Vol I-III, Penguin Books

Nelson, R. R. (1988), 'Institutions supporting technical change in the United States', in Dosi, G., Freeman, C., Nelson, R.R., Silverberg, G. and Soete, L.,(eds.), *Technology and economic theory*, London, Pinter Publishers.

Nelson, R.R. (ed.) (1993), *National Innovation Systems: A Comparative Analysis*, Oxford, Oxford University Press.

OECD (2000), Knowledge management in the learning economy, Paris, OECD.

Ostry, S. and Nelson, R. R. (1995), *Techno-nationalism and techno-globalism: Conflict and co-operation*, Washington D.C., Brookings Institution.

Patel, P. (1995), 'Localized production of technology for global markets', in *Cambridge Journal of Economics*, vol. 19, no. 1.

Polanyi, M. (1958/1978), *Personal Knowledge*, London, Routledge & Kegan.

Polanyi, M. (1966), *The Tacit Dimension*, London, Routledge & Kegan.

Porter, M. (1990), *The competitive advantage of nations*, London, MacMillan..

Romer, P.M. (1990), 'Endogenous technological change', *Journal of Political Economy*, Vol. 98.

Rosenberg, N. (1982), *Inside the black box: Technology and Economics*, Cambridge UK, Cambridge University Press.

Rothwell, R. (1977), 'The characteristics of successful innovators and technically progressive firms', R&D Management, No 3, Vol. 7, pp. 191-206.

Sako, M. (1990), 'Buyer-supplier relationships and economic performance: evidence from Britain and Japan', Ph. D. thesis, University of London.

Segura-Bonilla, O. (1999*), Sustainable Systems of Innovation: The Forest Sector in Central America*, SUDESCA Research Papers No 24, PhD dissertation, Department of Business Studiea, Aalborg University.

Svennilson, I. (1960), 'The Concept of the Nation and its Relevance to Economic', in Robinson, E. A. G. (ed.) (1960*), Economic Consequences of the Size of Nations*, Proceedings of a Conference held by the International Economic Association, Macmillan, London.

Stewart, F. (1977), *Technology and Underdevelopment*, London.

Tomlinson, M. (2001), 'A new role for business services in economic growth', in Archibugi, D. and Lundvall, B.-Å. (eds.) (2001), *Europe in the Globalising Learning Economy*, Oxford, Oxford University Press.

Tylecote, A. (1994), 'Financial systems and innovation', in Dogson, R. and D. Soskice (eds.), *Handbook of industrial innovation*, Cheltenham, Edward Elgar.

Wagner, M. (1998), *Det polytekniske gennembrud* (The polytechnical breakthrough), Aarhus, Aarhus University Press.

Walsh, V. (1987) 'Technology, competitiveness and the special problems of small countries', *STI Review*, 2: 81-133. The Organisation for Economic Co-Operation and Development (OECD), Directorate for Science, Technology and Industry, Paris: OECD.

Whitley, R. (1994), Societies firms and markets: The social structuring of business systems, in Whitley, R. (ed.), *European business systems*, London, Sage Publications.

Woolcock, M. (1998), 'Social capital and economic development: toward a theoretical synthesis and policy framework', *Theory and Society*, No. 2, Vol. 27, pp. 151-207.

Appendix: GLOBELICS - GLOBal network for Economics of Learning, Innovation and Competence building Systems

The basic idea behind GLOBELICS is to establish *a global network* of scholars who have in common that they apply the concept 'system of innovation and competence building' as their analytical framework. The network will be established around a core group of Danish research institutions, including the IKE-group at Aalborg University. Other European centres may be established in Lisbon and Paris. Regional nodes will be established in Rio, Hawaii, Cape Town, Moscow and Beijing. The first major gathering may take place in November 2002 – probably in Rio.

The GLOBELICS network relates to the concept of the network society and ICT-learning. The focus of the network will be on processes of competence building in networks using information and communication technologies. Comparative studies across continents and cultures will be stimulated and co-ordinated by Globelics. An analytical perspective will be applied to the interaction in the Globelics network itself in order to evaluate the relative efficiency of different media when it comes to cross-continental and cross-cultural competence building.

The background for the project is that the growing use of the *internet opens up new risks as well as new windows of opportunity for less developed economies*. The project will focus on the potentialities and limitations of ICT in the context of competence building and innovation. The *value premise* behind the project is the recognition of a need to give more equal opportunities to scholars in emerging economies in the Southern and Eastern Hemispheres.

Purpose

The objective is to analyse the conditions for successful cross-continental and cross-cultural interaction *aiming at competence building in a new and interdisciplinary academic field* of special importance for *emerging economies*. The major activity in the network will be to co-ordinate analytical efforts to understand the workings of systems of innovation and competence-building in different parts of the world and to promote strategies that make such systems more geared to socio-economic needs and to take into account ecological barriers. This implies intelligent strategies for the implementation and use of information and communication technologies in specific structural, institutional and cultural contexts.

The secondary idea is to experiment within Globelics with the use of *different media* for interaction and mutual competence-building spanning from *long-distance inter-net communication* to *face to face apprenticeship methods*. An advanced *web-site* and new forms of advanced telecommunication will bring together interesting information about what is going on and to share experiences worldwide regarding methodological issues,

analytical results and policy relevant experiences. But the web-site will be combined with face to face communication in connection with *regular conferences and mutual visits*. Since it is a primary purpose to understand the conditions for successful competence-building, including the role of new network technologies there is a need to apply *theories on education, knowledge and learning*.

Organisation

The *co-ordinator* will be supported by an *International Advisory Board* that, besides those responsible for regional nodes, will include scholars who have made important contributions to the analysis of national innovation systems. Christopher Freeman, Sussex University, Richard Nelson, Columbia University, Sanjaya Lall, Oxford University and Lynn Mytelka at the UNITECH research centre in Maastricht are among those who have expressed interest to join the project. A network of *national scientific correspondents* will be established.

Aalborg 2001-05-18

Bengt-Åke Lundvall