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Innovation and Competence Building in the Learning  
Economy – Implications for innovation policy

Kunnskapsdugnaden 2008

Delprojekt om Kunnskap og læringsøkonomi

By

Bengt-Åke Lundvall

# **Innovation and Competence Building in the Learning Economy – Implications for Innovation Policy**

Kunnskapsdugnaden 2008

Delprojekt om Kunnskap og læringsøkonomi

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## **Abstract**

This memorandum has been worked out in the context of 'Kunnskapsdugnaden'. A major national effort to develop and national innovation policy strategy for Norway organised by Tekna (the national union of engineers), LO (the national union of workers) and NAF (The national association of employers). It brings together central results from research on innovation and relates those results to main characteristics of the Nordic countries. It makes the following points:

The distinction between knowledge about the world, easy to codify, and know-how, embodied in people or embedded in organizations, is crucial for theory and policy.

The corresponding distinction between science- and experience-based learning helps understand why the link from the science-base to innovation performance is weak.

The skill-biased technical change in the current era reflects 'the learning economy' where the rate of change in technologies and organization has accelerated.

In the learning economy there is a need to rethink the role of education, and of universities, and give more attention to personal skills and interaction with practice.

Nordic countries perform well both in the long and the medium term on the basis of a kind of social capital and trust that supports organizational and interactive learning.

Rather than moving directly to public policy issues the memo first gives attention to conceptual issues and to new empirical results relevant for the design of public policy.

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# **Innovation and competence building in the learning economy – Implications for innovation policy**

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September 2008  
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## **1. Introduction**

The idea that knowledge matters for the economy is far from new. Adam Smith (1776) refers to the division of labor among specialized ‘men of speculation’ as an important source of innovation. Friedrich List (1841) argues that the most important form of capital is ‘mental capital’. Karl Marx (1868) pointed to science as an important productive force. In the 20<sup>th</sup> century the British scholar Bernal (1936) proposed that raising investments in R&D from 0.2% to 2% in Great Britain would stimulate the economy and bring a new kind of economic growth and a similar message was formulated in ‘The Endless Frontier’ by Vannevar Bush (1945) that laid the foundation of post-war science policy in the US.

In the last part of the 1950’s Kenneth Arrow (1962b) and Richard Nelson (1959) gave economic arguments for why governments should support or even organize the production of scientific knowledge in the second part of the Fifties. OECD has played a major role in the analysis of science as a productive factor (OECD 1963, OECD 1971). Most of this work was based upon a linear model where it was assumed that advances in science would more or less automatically be transformed into new technology and market success. In OECD (1992) new insights from innovation research changed this perspective. It was realized that innovation came out of an interaction among several actors and that feed-backs from markets were critical for innovation. The concept of innovation system was taken aboard.

In the middle of the 1990s OECD initiated a new discourse on knowledge and economic development and started to refer to the knowledge-based economy, the learning economy and the learning society (Foray and Lundvall 1996, OECD 1996, OECD 2000). In parallel the concept of ‘the new economy’ took hold widely at OECD (2001). With inspiration from Alan Greenspan, President of US Federal Reserve, many OECD-economists began, for the first time, to see science and technology as a factor that should be taken into account when analyzing macro-economic dynamics.

In this memo I will not dwell upon the details of this history. Rather I will present a synthesis of what has come out of these research efforts and relate them to some of the main characteristics of the Nordic countries. I will make the following points:

1. The distinction between knowledge about the world, easy to codify, and know-how, embodied in people or embedded in organizations, is crucial for theory and policy.
2. The corresponding distinction between science and experience based learning helps understand why the link from the science base to innovation performance is weak.
3. The skill-biased technical change in the current era reflects ‘the learning economy’ where the rate of change in technologies and organization has accelerated.
4. In the learning economy there is a need to rethink the role of education, and of universities, and give more attention to personal skills and interaction with practice.
5. Nordic countries perform well both in the long and the medium term on the basis of a kind of social capital and trust that supports organizational and interactive learning.

Rather than moving directly to public policy issues the memo first gives attention to conceptual issues and to new empirical results relevant for the design of public policy. After each section I will discuss principles and implications for public policy without aiming at detailed recommendations – this need to be worked out in the concrete context of the specific national system and in a dialogue with major social partners. In *Appendix A* Edward Lorenz gives an update of data on work organization in Europe that includes Norway in the analysis. In *Appendix B* I sketch a bold general theory on the deepening of the division of labor, interactive learning and economic development.

## **2. The economics of knowledge**

Today there is a quite generalized assumption that knowledge is important for the economy. But the effort to understand what knowledge is and how it is transmitted into economic performance is not correspondingly ambitious. There is a bias in much of the economics literature as well as in policy practice in favor of knowledge as information and this has serious negative consequences both for analysis and policy.

### *2.1 Is knowledge a public good?*

Sidney Winter concluded his seminal paper on knowledge management strategy by pointing out that there is “a paucity of language” and “a serious dearth of appropriate terminology and

conceptual schemes” (Winter, 1987). Since then, the number of relevant publications has grown (see for instance OECD 2000; Foray 2000; Amin and Cohendet 2004) but still there is little agreement on what distinctions between different kinds of knowledge are most useful for understanding the interaction between knowledge and economic development.

Knowledge and information appear in economic models in two different contexts. The most fundamental assumption of standard microeconomics is that the economic system is based on *rational choices made by individual agents*. Thus, *how much and what kind of information* agents have about the world and their *ability to process the information* are crucial issues.

The other major perspective is one in which knowledge is regarded as an *asset*. Here, knowledge may appear both as input (competence) and output (innovation) in the production process. Under certain circumstances, it can be privately owned and/or bought and sold in the market as a commodity. The economics of knowledge is to a high degree about specifying the conditions for knowledge to appear as ‘a normal commodity’, i.e. as something similar to a producible and reproducible tangible product.<sup>1</sup>

In what follows, attention is on knowledge in this latter sense. When analyzing knowledge as an *asset*, its properties in terms of transferability across time, space and people is central. This fundamental issue is at the core of two quite different strands of economic policy debate. One is about the public/private dimension of knowledge and the role of government in knowledge production; the other is about the formation of industrial districts and the local character of knowledge.

Is knowledge a private or a public good? In economic theory, the properties that give a good the attribute of ‘public’ are that benefits can be enjoyed by many users concurrently as well as sequentially without being diminished (non-rivalry) and that it is costly for the provider to exclude unauthorized users (non-excludability).

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<sup>1</sup> Knowledge differs from tangible assets in many important respects and market failure is the rule rather than the exception (Arrow 1962a; Arrow 1971; Arrow 1974). In markets for knowledge it is difficult for the buyer to assess its value without knowing the content and if the content is known the buyer would not pay for it. The seller does not lose access to it when it is sold. It may be expensive to produce but often it is much less expensive to reproduce. Most important is that some forms of knowledge it is not scarce in the same sense as a tangible asset – the more know-how is used the more it grows and develops. This is why it is problematic to apply standard economic models and why the design of an institutional framework that supports the formation and distribution of knowledge is a major task for governments.

One reason for the interest in this issue is that it is crucial for defining the role of government in knowledge production. If knowledge is a public good that can be accessed by anyone, there is no economic incentive for rational private agents to invest in its production. More generally, if it is less costly to imitate than to produce new knowledge, the social rate of return would be higher than the private rate of return and, again, resource allocation would be inefficient since private agents would invest too little. Nelson's (1959) and Arrow's (1962b) classical contributions demonstrated that, in such situations, there is a basis for government policy either to subsidize or to take charge directly of the production of knowledge. Public funding of schools and universities, as well as of generic technologies, has been motivated by this kind of reasoning, which also brings to the fore the need for legal protection of knowledge, for instance by patent systems.

This fundamental problem remains at the core of the economics of knowledge production and recent developments have actually led to a reinforcement of intellectual property rights (Granstrand 2005). At the same time, another strand of thought, with roots in the history of economic thought, has become more strongly represented in the debate in the last decades especially among regional economists. Marshall (1923) was preoccupied by the phenomenon of *industrial district*: why is it that certain specialized industries locate in certain regions in England and why do they remain competitive for long historical periods?

He argued that 'knowledge is in the air'. But his principal explanation was that knowledge was localized in the region because it was rooted in the local labor force and in local institutions and organizations. This perspective, with its focus on localized knowledge, resurfaced strongly among industrial and regional economists over the last decades – one reason was the Silicon Valley-phenomenon and the growing interest for promoting knowledge-based regional industrial clusters.<sup>2</sup>

These two perspectives, while seemingly opposed in their contrasting emphasis on respectively a need to protect and the difficulty to share knowledge, raise fundamental questions: Is the consent of the producer needed for the mediation to be successful or can knowledge be copied against the will of the producer? How difficult is it to transfer knowledge and what are the transfer mechanisms? Is it possible to change the form of

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<sup>2</sup> Markusen (1996) gives an excellent overview over the analytical work on industrial districts showing why and how some knowledge remains 'sticky' in a 'slippery' space.

knowledge (through codification) so that it becomes easier (more difficult) to mediate? How important is the broader socio-cultural context for the transferability of knowledge? The distinctions between different kinds of knowledge proposed below aim at throwing light upon these issues.

## 2.2 *A terminology of knowledge*

In earlier work we have proposed that it is useful to divide knowledge into four categories (Lundvall and Johnson, 1994).

- Know-what
- Know-why
- Know-how
- Know-who

*Know-what* refers to knowledge about ‘facts’. How many people live in New York, what are the ingredients in pancakes are, and when the battle of Waterloo took place are examples of this kind of knowledge. Here, knowledge is close to what is normally called information – it can be broken down into bits and communicated as data.

*Know-why* refers to knowledge about principles and laws of motion in nature, in the human mind and in society. This kind of knowledge is extremely important for technological development in certain science-based areas, such as the chemical and electric/electronic industries. Access to this kind of knowledge will often make advances in technology more rapid and reduce the frequency of errors in procedures involving trial and error.

*Know-how* refers to skills – *i.e.* the ability to do something. It may be related to the skills of artisans and production workers. But it plays a key role in all important economic activities. The businessman judging the market prospects for a new product or the personnel manager selecting and training staff use their know-how. One of the most interesting and profound analyses of the role and formation of know-how is actually about scientists’ need for skill formation and personal knowledge (Polanyi, 1958/1978).

*Know-who* involves information about who knows what and who is expert in solving specific tasks. But it also involves the social ability and social capital that makes it possible to cooperate and communicate with people and experts. Know-who becomes increasingly important with the general trend towards a more composite knowledge base. New products typically combine many technologies, each of which is rooted in several different scientific disciplines, and this makes access to many different sources of knowledge more essential

(Pavitt, 1998). No single person or organization can host all the kinds of expertise needed to pursue innovation processes.

### *2.3 How public or private are the four kinds of knowledge?*

Databases bring together ‘know-what’ in a more or less user-friendly form. The effectiveness of search machines is highly relevant in this context (Shapiro and Varian, 1999). Still today, the most effective medium for obtaining pertinent facts may be through the ‘know-who’ channel, *i.e.* contacting an outstanding expert in the field to obtain directions on where to look for a specific piece of information.

Scientific work aims at producing *know-why*, and some of this work is placed in the public domain. Academics have strong incentives to publish and make their results accessible (but new regulations introducing intellectual property rights to university administrations may undermine the public character of science!). The Internet offers new possibilities for speedy electronic publishing. Open and public access is of course a misnomer, in that it often takes enormous investments in learning before scientific information has any meaning for a user. Again know-who, directed towards academia, can help the non-specialist to obtain a translation into something comprehensible.

Know how is characterized by limited public access and mediation is complex. The basic problem is that it is impossible to separate the competence to act from the person or organization that acts. The outstanding expert – cook, violinist, manager – may write a book explaining how to do things, but what is done by the amateur on the basis of that explanation is, of course, less perfect than what the expert would do. Attempts to use information technology to develop expert systems show that it is difficult and costly to transform expert skills into information that can be used by others. It has also been demonstrated that the transformation always involves changes in the content of the expert knowledge (Hatchuel and Weil 1995).

Know who refers to a combination of information and social relationships. Telephone books that list professions as well as databases that list producers of certain goods and services are in the public domain and can, in principle, be accessed by anyone. In the economic sphere, however, it is extremely important to get access to highly specialized competencies and to find the most reliable experts, hence the importance of good personal skills and relationships with key persons one can trust. These social and personal relationships are by definition not public. They cannot be transferred and, more specifically, they cannot be bought or sold on

the market. As pointed out by Arrow (1971), “you cannot buy trust and, if you could, it would have no value whatsoever”.

The social context may support, to a greater or lesser degree, the formation of know-who knowledge while the cultural context determines the form it takes. This is an important aspect of the concept of social capital (Woolcock, 1998). In this memo we will go as far as arguing that the unique levels of trust in the Nordic countries may be seen as the most important and generic explanation of their (paradoxically) strong economic performance (see section 6 and Appendix A).

#### *2.4 Knowledge is both public and private*

It is clear from what has been said that very little knowledge is ‘perfectly public’. Even information of know-what type may be impossible to access for those not connected to the right telecommunications or social networks. Scientific and other types of complex knowledge may be perfectly accessible, in principle, but for effective access the user must have invested in building absorptive capacity.

On the other hand, little economically useful knowledge is completely private, at least not in the long run. Tricks of the trade are shared within the profession. Know-how can be taught and learnt in interaction between the master and the apprentice. Even when the possessor of private knowledge does not want to share it with others there are ways to obtain it, such as engaging in reverse engineering. If necessary, private agents will engage in intelligence activities aimed at getting access to competitors’ secrets.

Different parts of economic theory handle this mixed situation differently. Underlying much of the neo-classical theory of production and growth is the simplifying assumption that there is a global bank of blueprints from which anybody can get a copy to be used for starting up production. Knowledge is here assumed to be public and to correspond to information. The resource based theory of the firm takes the opposite view and assumes that the unique competence of the firm determines the directions in which it expands its activities (Penrose, 1958).

In real life there is not one common knowledge base and neither is knowledge completely private and individualized. The most appropriate understanding may be to refer to a multitude of *knowledge pools* to which access is limited by law, organizational borders, physical distance or professional background. It implies that in order to get access to relevant pools

individuals have to engage simultaneously in copying well-known routines from others, exploiting internal capabilities and engage in building new competence. Below we will refer to these activities as individual and organizational learning. This is what makes management a difficult art quite different from firms' effortless information access modeled in neo-classical economics text-books.

### *2.5 On tacitness and codification of knowledge*

There has been a lively debate among economists about the role of tacitness and codification of knowledge (Cowan, David and Foray, 2000; Johnson, Lorenz and Lundvall, 2001). The reason for the interest is, of course, that tacitness relates to the transferability and the public character of knowledge. Codified knowledge is potentially shared knowledge while non-codified knowledge remains individual, at least, until it can be learnt in direct interaction with the possessor. An important issue in this context is how much effort should be made to codify knowledge.

Sectors where the knowledge base is dominated by non-codified but potentially codifiable knowledge may be sectors where progress towards more efficient practices is difficult. Economists have used education as a typical example of a production process characterized by tacit techniques (Murnane and Nelson, 1984). OECD (2000) presents a unique attempt to compare the production, diffusion and use of knowledge across some important economic and societal sectors – information technology, management science as well as health and education.

What has been considered as important attributes of knowledge (public/private; codified/tacit) suggests that there may be marked differences among various sectors with regard to their knowledge base. Some science-based sectors depend upon codified knowledge while others operate and compete mainly on the basis of unstructured and experience-based implicit knowledge. But there are no pure cases and one of the points made in section 4 below is that firms with a weak foundation in codified/scientific knowledge may have most to gain from engaging in science-based learning. Vice versa firms specialized in the use of scientific knowledge may have most to gain from engaging in organizational learning and focusing on customer needs in order to promote the formation of tacit knowledge.

### *2.6 Policy implications*

At this general level only limited conclusions can be drawn for public policy. One obvious conclusion is that knowledge politics needs to have two different dimensions. One is about the protection of strategic knowledge and the other is about promoting the absorption and diffusion of knowledge. To strike the right balance between the two dimensions is far from a trivial task. While knowledge owners may be very outspoken in favor of more protection the general interest of public access may have less powerful spokespersons.

Another conclusion, strongly supported by the analysis in OECD (2000) is that the mix of private and public as well as tacit and codified knowledge differs across different sectors in the economy. This implies that whatever general policy measures that are implemented will turn out to be selective policy since they affect different sectors differently (e.g. the sectors producing codified knowledge versus sectors that are users of codified knowledge). If governments become hostages of the private interest of knowledge producers it may have negative consequences for the diffusion and wide use of knowledge.

### **3. Toward the learning economy**

Many indicators show that there has been a shift in economic development in the direction of a more important role for knowledge production and learning both in the long and the medium term. Moses Abramowitz and Paul David (1996) have demonstrated that this century has been characterized by increasing knowledge intensity in the production system. OECD's structural analysis of industrial development in the post-war period points in the same direction. It has been shown that the sectors that use knowledge inputs such as R&D and skilled labor most intensively are the ones that grow most rapidly. At the same time, the skill profile is on an upward trend in almost all sectors. In most OECD countries, in terms of employment and value added, the most rapidly growing sector is knowledge-intensive business services (OECD, 1999).

These observations have led more and more analysts to characterize the new economy as 'knowledge-based', and there is in fact a relative shift in the demand for labor towards more skilled workers. Perhaps the most pertinent result coming out of OECD Job's Study was that in *all* member countries the relative position of high-skilled workers became stronger while low-skilled workers were weakened in terms of pay or employment in the period 1985-95 (OECD, 1994).

Below we will argue that this shift in demand can be explained most adequately with reference to 'the learning economy'. While a reference to 'skill-biased technical progress'

leaves it open why there has been a shift in the demand for knowledge the learning economy perspective may contribute to an explanation of the phenomenon. To explain this change we need to ask the question why and under what circumstances do highly educated people contribute more to the economy than those with little education? We will refer to Nelson and Phelps (1966) and to Schultz (1975) in order to provide some of the answers.

Nelson and Phelps (1966) present a simple growth model where people with higher education contribute to economic growth through two mechanisms. First they are able to pursue regular activities more efficiently than the average worker. Second, and here is the new insight brought by the paper, *they are more competent when it comes to exploit new technical opportunities*. The conclusion from the analysis is that the marginal productivity of the highly educated will reflect the rate of technical change (exogenously given in the model). *In other words the rate of return on investment in higher education will be positively correlated with the rate of technical progress*. In a stationary economy we would expect the rate of return to be low while we would expect it to be high in an economy characterized by rapid technical change. *A general conclusion is that the role of higher education needs to be assessed in the wider context of the national innovation system and that higher education policy needs to be coordinated with a wider set of innovation policies*.

Schultz (1975) follows a similar line of thought but takes the reasoning some steps further. The title – ‘The value of the ability to deal with disequilibria’ – as well as the reasoning is intriguing, not least since it comes from an economist belonging to the Chicago-tradition within economics based upon general equilibrium analysis. Schultz argues on the basis of empirical observations that education makes individuals better prepared to deal with disequilibria. When the individual is exposed to change in terms of new technological opportunities he/she will be more or less competent in finding a solution and it is assumed that one major impact of education is to enhance this competence which Schultz refers to as ‘entrepreneurial’.

In a series of Ph.D.-dissertations organised at Department of Business Studies, Aalborg University, different aspects of the role of higher education in processes of innovation have been analysed (Vinding 2002, Nielsen 2007). Taking into account a number of factors that may affect the propensity to innovate we find a positive effect on the propensity to innovate of having employees with a graduate degree. This effect is especially strong in small and medium-sized firms operating in low and medium technology sectors (see Lund Vinding 2004). The role of graduates in small firm innovation has been analyzed more in depth in

Nielsen (2007). The analysis is focused upon 200 small Danish firms originally without academic personnel. The analysis demonstrates that – taking into account a series of relevant control variables – the first-time hiring of a graduate with an engineering background has a significant positive impact on the propensity to introduce a new product (Nielsen 2007).

This points to an interpretation of the increase in the demand for skilled labor as reflecting an acceleration in the rate of change that gives a premium to those who have a higher education and thereby can be expected to be better prepared to cope in an economy characterized by rapid change. Higher rates of innovation and the permanent opening up of new disequilibria lie behind what has been registered as skill-biased technical progress. The implications for the content and organization of education will be discussed in section five below.

### *3.2 The learning economy*

As argued in the last section, the observed skill bias in OECD (1994) supports the hypothesis that since the middle of the 1980s there has been acceleration in the rate economic and technical change imposing a strong transformation pressure not least on the small open high income economies (Lundvall, 1992; Drucker, 1993; Lundvall and Johnson, 1994; Archibugi and Lundvall, 2001). Behind the acceleration of change lie shorter product life cycles and intensified international trade as well as politically driven deregulation. At the level of the firm, it is registered as an intensification of competition. At the level of the individual it is experienced as a need permanently to renew skills and competences in order to remain ‘employable’.

Change and learning are two sides of the same coin. The speed-up of change confronts people and organizations with new problems and to tackle the new problems requires new skills (OECD 2000). The process is characterized by cumulative circular causation (cf. Myrdal 1968). The selection by employers of more learning-oriented employees and the market selection in favor of change-oriented firms accelerate further innovation and change. There is nothing to indicate that the process will be slowed down in the near future. Rather, the further deregulation of markets for services, the growth of exports from China and India, the radical change in relative prices of energy and raw materials all give new momentum to the process.

### *3.3 Policy implications*

In a small open economy the key to economic success in the globalizing learning economy is to transform the economy so that exposed activities are either upgraded or substituted for by

new activities more intensive in the use of competence. It is a major task to design institutions that regulate education and labor markets so that they promote processes of learning and the formation and diffusion of learning organizations in the private and public sector. As will be demonstrated in the next section it is not sufficient to promote R&D-efforts and the training of scientists and engineers. We will argue that the broad participation of workers in processes of change has been fundamental for the relative success of the Nordic countries.

This indicates a fundamental internal contradiction in the learning economy that may require public intervention in the process. If left to itself it leads to increasing inequality that erodes its foundation in social cohesion and trust. This reflects a Matthews syndrome when it comes the distribution of knowledge. High skilled have privileged access to formal training at the enterprise level (Lundvall 2001) and they get jobs offering more learning opportunities (Tomlinson 1999). Acceleration in the rate of change may result in a growing gap between skilled and unskilled workers in terms of employment opportunities and income. This has important implications for public policy related to the formation of competences especially among the low-skilled segments of the work-force.

## **4. Modes of innovation and innovation performance**

### *4.1 Introduction*

In section 2 we made a distinction between codified and tacit knowledge. In this section we will introduce two modes of learning related to this distinction. We present recent data and analysis showing that firms that combine R&D-efforts (STI-learning) with organizational learning and interaction with customers (DUI-learning) are the most innovative (Jensen et al 2007). The idea that it is useful to make a distinction between these two modes of innovation is far from new. In the introduction to the Wealth of Nations Adam Smith presents a case story about a worker who on the basis of his experience finds a way to make a machine more efficient and in the following paragraphs he points to ‘men of speculation’ who specialize in finding new production methods (Adam Smith 1776, pp. 8-9)

Inspired by Adam Smith and by the more recent distinction between tacit and codified knowledge, we define two modes of innovation (Jensen et al, 2007). On the one hand there are innovation strategies that give main emphasis to promoting R&D and creating access to explicit codified knowledge (Science, Technology, and Innovation, STI-mode). On the other hand there are innovation strategies (Doing, Using, and Interacting, DUI-mode) mainly based

on learning by doing, using and interacting. We show that firms using mixed strategies that combine a strong version of the STI-mode with a strong version of the DUI-mode excel in product innovation.

The *STI-mode of innovation* refers to the way firms use and further develop a body of science-like understanding in the context of their innovative activities. Over the twentieth century, and still today, a major source for the development of this knowledge about artifacts and techniques has been the R&D laboratory of the large industrial firm (Mowery and Oxley, 1995, Chandler, 1977). The STI-mode of learning even when it starts from a local practical problem will make use of ‘global’ knowledge all the way through and, ideally, it will end up with ‘potentially global knowledge’ – i.e. knowledge that could be used widely if it were not protected by intellectual property rights.

The *DUI-mode of innovation* refers to learning at the job as employees face on-going changes that confront them with new problems and learning in an interaction with external customers. Finding solutions to problems enhances the skills and know-how of the employees and extends their repertoires. The DUI-mode of learning refers to knowledge that is tacit and often highly localized. While this kind of learning may occur as an unintended by-product of the firm’s design, production and marketing activities, the point we want to make here is that the DUI-mode can be intentionally fostered by building structures and relationships which enhance and utilize learning by doing, using and interacting. In particular, we assume that interaction with users and organizational practices such as project teams, problem-solving groups, and job and task rotation, which promote learning and knowledge exchange, contribute to innovation performance.

#### *4.2 Illustrating empirically how DUI and STI-learning promote innovation*

In what follows we will show that the probability of successful product innovation increases when the firm has organized itself in such a way that it promotes DUI-learning. We will also show that firms that establish a stronger science base will be more innovative than the rest. But the most significant and important result is that firms using mixed strategies that combine organizational forms promoting learning with R&D-efforts and with co-operation with researchers at knowledge institutions are much more innovative than the rest. *It is the firm that combines a strong version of the STI-mode with a strong version of the DUI-mode that excels in product innovation.*

Two of three measures we use to capture STI-mode learning are standard measures used to benchmark science and technology development in innovation policy studies: expenditures on R&D; and the employment of personnel with third-level degrees in science or technology. The third measure – cooperation with researchers attached to universities or research institutes – though of recognized importance is less commonly used in policy studies due to the lack of survey data. For DUI-mode learning we use organizational characteristics assumed to characterize the learning organization (such as integration of functions and interdisciplinary workgroups) including also an indicator for the interaction with users.

### *4.3 The four clusters*

In order to find out how the different aspects of establishing a learning organization tend to be combined with the capacity to handle scientific and codified knowledge we have pursued a clustering across firms using latent class analysis. The first cluster is a static or low learning cluster and encompasses about 40% of the firms. The second cluster, which we refer to as the STI cluster, encompasses about 10% percent of the firms. Firms belonging to the STI cluster have activities that indicate a strong capacity to absorb and use codified knowledge. The third cluster, which we refer to as the DUI cluster, brings together about one third of the firms in a group that is characterized by an over-average development of organizational characteristics typical for the learning organization but without activities that indicate a strong capacity to absorb and use codified knowledge.

The fourth cluster includes firms using mixed strategies that combine the DUI and STI modes. It includes one fifth of the firms and these firms tend to combine the characteristics indicating a strong capacity for informal experience-based learning with activities that indicate a strong capacity to absorb and use codified knowledge.

Table 1 shows the frequency distribution of the different clusters by firm size, industry, group ownership and production. It is clear that the different clusters are distributed unevenly across industry, size and ownership. In terms of sector, it is not surprising to find that construction, trade and other services, are underrepresented in the STI and DUI/STI clusters given the relatively low levels of R&D expenditure that characterize these sectors.

One interesting observation is that *the match between High Tech manufacturing sectors and STI-learning is far from perfect*. Almost 50% of the high tech firms do not appear to be strong in STI-learning while more than 35% of the Low Tech manufacturing firms do have a strong STI- learning mode. This confirms that the traditional definition of high versus low

technology sectors is highly problematic especially if the size of the High Tech sector is used as indicator of innovation performance.

Table 1: The frequency of the three clusters by firm size, sector, group ownership and production type (percent horizontal)

Variables:	Low Learning	STI Cluster	DUI Cluster	DUI/STI Cluster	<i>N</i>
Less than 50 employees	0.5605	0.0855	0.2566	0.0973	339
50 - 99 employees	0.3314	0.1775	0.3018	0.1893	169
100 and more employees	0.2457	0.1257	0.2686	0.3600	175
Manufacturing, high tech	0.2231	0.2645	0.2314	0.2810	121
Manufacturing, low tech	0.3522	0.1321	0.2893	0.2264	159
Construction	0.6139	0.0495	0.2574	0.0792	101
Trade	0.5780	0.0462	0.3064	0.0694	173
Business service	0.2727	0.0909	0.2576	0.3788	66
Other services	0.6512	0.0465	0.2791	0.0233	43
Danish group	0.4073	0.1371	0.2460	0.2097	248
Foreign group	0.2903	0.1694	0.2903	0.2500	124
Single firm	0.4890	0.0789	0.2776	0.1546	317
Standard product	0.3574	0.1687	0.2851	0.1888	249
Customized product	0.4518	0.0871	0.2635	0.1976	425
All firms	0.4249	0.1171	0.2673	0.1908	692

Source: Jensen et al (2007)

In order to examine the effect of the learning modes on the firm innovative performance we use logistic regression analysis as reported in Table 2. The dependent variable for this exercise is whether or not the firm has introduced to the market a new product or service (P/S innovation) over the last three years. The independent variables in the Model 1 specification are binary variables indicating whether or not the firm belongs to a particular cluster. In the Model 2 specification we include control variables to account for the effects of industry, firm size, ownership structure, and whether the firm produces customized or standard products.

Overall, the results of the logistic analysis show that adopting DUI-mode enhancing practices and policies tends to increase firm innovative performance. Further, they support the view that

firms adopting mixed strategies combining the two modes tend to perform better than those relying predominantly on one mode or the other.

Table 2: Logistic regression of learning clusters on product/service innovation

Variables	Model 1 (without controls)		Model 2 (with controls)	
	Odds ratio estimate	Coefficient estimate	Odds ratio estimate	Coefficient estimate
STI Cluster	3.529	1.2611**	2.355	0.8564**
DUI Cluster	2.487	0.9109**	2.218	0.7967**
DUI/STI Cluster	7.843	2.0596**	5.064	1.6222**
Business services			1.433	0.3599
Construction			0.491	-0.7120*
Manufacturing (high tech)			1.805	0.5905*
Manufacturing (low tech)			1.250	0.2229
Other services			0.747	-0.2923
100 and more employees			1.757	0.5635*
50-99 employees			0.862	-0.1481
Danish group			0.859	-0.1524
Single firm			0.521	-0.6526*
Customised product			1.378	0.3203
Pseudo R <sup>2</sup>	0.1247	0.1247	0.1775	0.1775
N	692	692	692	692

\*\* = significant at the .01 level; \* = significant at the .05 level

Our cluster analysis indicates that many firms that are involved in STI-learning have established organizational elements related to the DUI-mode. They will operate in sectors where there is supply-driven and sometimes radical change in products and processes. To cope with these changes the need for learning by doing, using and interacting will be strongly felt. Likewise, for firms in traditional sectors it is no longer sufficient to base competitiveness on know-how and DUI-learning. Firms that connect more systematically to sources of codified knowledge may be able to find new solutions and develop new products that make

them more competitive. Moreover, the cluster analysis shows that what really improves innovation performance is using mixed strategies that combine strong versions of the two modes.

#### *4.4 Policy implications*

Our results strongly suggest a need for realignment of policy objectives and priorities, given the tendency to develop innovation policy with a one-sided focus on promoting the science-base of high-technology firms. Actually both a strategy that promotes organizational learning in STI-firms and one that promotes STI-learning in DUI-firms may have greater effect on innovation than promoting R&D in firms that are already experienced in pursuing it. Too little attention is being given to policies that serve to strengthen linkages to sources of codified knowledge for firms operating in traditional manufacturing sectors and services more generally. The fact that the first-time hiring of a graduate has a significant positive impact on the propensity to innovate (Nielsen 2007) indicates that there are cultural barriers to implementing elements of the STI-mode in such sectors – barriers that could be overcome through temporary marginal employment subsidies addressed specifically to Small and Medium sized firms in traditional sectors.

Thinking in terms of the two modes and their evolution in the learning economy may also have implications for wider aspects of public policy and institution building. In the following section we will argue that the education of graduates and their hiring in industry is the best way to transmit both codified and tacit knowledge and upgrade both DUI and STI-learning in the business sector. Organizing innovation policy and distributing responsibility between, for instance, ministries of education, science, industry and economic affairs needs to balance the two modes in innovation policy. If the main responsibility is given to a ministry of science the STI-bias in innovation policy is reinforced.

### **5. Education in the learning economy**

Education systems and schools are often seen as sites where knowledge about the world is transmitted from the teacher to the student. But education also forms personalities and personal social skills. The idea of education as a process where you fill empty bottles, the form of which is determined elsewhere, is as widely shared as it is inadequate (Guile 2003). In the learning economy this dimension of education becomes especially important. This is true for all categories of workers from the top management to the man/woman on the floor.

One crucial issue is to what degree a specific education system creates social barriers between the two categories and between different professions (Lundvall, Lorenz and Rasmussen 2008).

In this section we start with a closer look on how management in Danish firms refers to changes in the content of work in the 90s. In a context of accelerating change it is of particular interest to focus on changes in the competences demanded within firms that have engaged in organizational change (Gjerding 1997). We will move on to new data on how people learn at the job in different parts of Europe and see how learning at the job is related to national educational efforts. Finally we will discuss in more detail the role of universities in the national innovation system and especially the implications for how to design higher education programs.

### *5.1 Skill requirements and organizational change - challenges for education*

Table 3 reveals substantial differences in the pattern of answers between the firms that have introduced new forms of organization and those that have not (percentage of firms with numbers in parenthesis).

Table 3: Changes in task content for employees in the period 1993-95 for firms that have made organisational changes (outside the parentheses), compared with firms that have not made organisational changes (in parentheses).<sup>3</sup>

	More	Less	Unchanged	No answer
a. Independence of work	72,6 (37,1)	4,2 (2,7)	21,2 (56,3)	2,0 (3,8)
b. Professional qualifications	56,4 (36,3)	7,5 (5,3)	33,3 (53,8)	2,8 (4,4)
c. Degree of specialisation	33,9 (26,2)	20,8 (7,8)	39,3 (58,4)	6,0 (7,5)
d. Routine character of tasks	5,6 (8,2)	41,8 (15,5)	45,0 (67,1)	7,7 (9,1)
e. Customer contact	51,6 (29,3)	5,1 (3,1)	37,2 (59,9)	6,1 (7,6)
f. Contact with suppliers	34,9 (18,0)	7,1 (4,3)	46,4 (62,0)	11,6 (15,6)
g. Contact with other firms	24,7 (14,0)	5,5 (4,3)	56,8 (68,9)	13,0 (13,7)
h. Co-operation with colleagues	59,1 (27,1)	5,8 (4,5)	31,8 (63,3)	3,2 (5,0)
i. Co-operation with management	64,9 (28,6)	5,9 (4,2)	26,1 (62,2)	3,1 (4,9)

*Source:* Voxted 1999, DISKO-Survey, N=952 (981)

The importance of general skills reflected in growing demands for independence in the work situation, co-operation with external partners, especially customers, and for co-operation with

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<sup>3</sup> Management representatives in 4000 Danish private firms, excluding agriculture, were asked 'Did the firm introduce a non-trivial change in the organisation in the period 1993-95?' . The response rate was close to 50%. For more detailed information see Lundvall (2002a)..

management and colleagues, have grown remarkably in firms that have pursued organizational change and much less so in firms that have not changed their organization.

All firms, and especially those that engage in organizational change, require that employees can communicate and collaborate internally and externally. In subsection 5.4 we argue that this has major relevance for the design of higher education programs. It should be noted that learning at the job is more demanding and takes longer the higher the education level of the employee (Tomlinson 1999). To see the graduate as ready-made in terms of competences and reserve the analysis of on the job-training to low-skilled workers is thus a mistake.

Above we referred to Nelson and Phelps (1966) and Schultz (1975) who argue in different ways that education becomes more important in contexts of rapid and radical change. Here we can add that promoting entrepreneurship and initiative at the secondary level of technical training becomes increasingly important. When management can rely on these categories of workers to engage in change it frees valuable time for the more demanding tasks for those with a higher education. <sup>4</sup>

## *5.2 How Europe's economies learn*

Lorenz and Valeyre (2006) develop an original and informative EU-wide mapping of how employees work and learn in the private sector. Later it has been shown that it has wider implications for innovation and growth. In Arundel et al (2007) international comparisons show that there is a positive correlation between the national share of employees engaged in advanced forms of learning at the workplace and the percentage of private sector enterprises doing more radical forms of innovation.

Cluster analysis is used to identify four different systems of work organization:

- Discretionary learning (DL)
- Lean
- Taylorist
- Traditional forms

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<sup>4</sup> This point was made by professor emeritus Reinhard Lund with reference to a series of his case studies of innovation processes in Danish firms.

Two of these, the discretionary learning and lean forms, are characterized by high levels of learning and problem solving in work. The principal difference between the discretionary learning and the lean clusters is the relatively high level of discretion or autonomy in work exercised by employees grouped in the former. Task complexity is also higher in the discretionary learning cluster than in the lean cluster.

Discretionary learning thus refers to work settings where a lot of responsibility is allocated to the employee who is expected to solve problems on his or her own. Employees operating in these modes are constantly confronted with 'disequilibria' and as they cope with those they learn and become more competent. But in this process they also experience that some of their earlier insights and skills become obsolete.

Lean production also involves problem solving and learning but here the problems are more narrowly defined and the set of possible solutions less wide and diverse. The work is highly constrained and this points to a more structured or bureaucratic style of organizational learning that corresponds rather closely to the characteristics of the Japanese inspired 'lean production'-model.

The other two clusters are characterized by relatively low levels of learning and problem solving. The taylorist form leaves very little autonomy to the employee in making decisions. In the traditional cluster there is more autonomy but learning and task complexity is the lowest among the four types of work organization. This cluster includes employees working in small scale establishments in personal services and transport where methods are for the most part informal and non-codified.

Table 4 shows that people working in different national systems of innovation and competence work and learn differently. Discretionary learning is most widely diffused in the Netherlands, the Nordic countries and to a lesser extent in Austria and Germany. The lean model is most in evidence in the UK, Ireland and Spain. The taylorist forms are more present in Portugal, Spain, Greece and Italy, while the traditional forms are similarly more in evidence in these four southern European countries.<sup>5</sup> Within the Nordic group Denmark is

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<sup>5</sup> Lorenz and Valeyre (2006) use logit regression analysis in order to control for differences in sector, occupation and establishment size when estimating the impact of nation on the likelihood of employees being grouped in the various forms of work organisation. The results show statistically significant 'national effect' also when controlling for the structural variables, thus pointing to considerable latitude in how work is organised for the same occupation or within the same industrial sector.

extreme in terms of its high share of discretionary learning and low share of taylorist workplaces. The share of discretionary learning is higher in Germany than it is in the UK and France.

Table 4: National Differences in Organisational Models (percent of employees by organisational class)

	<b>Discretionary learning</b>	<b>Lean production learning</b>	<b>Taylorist organisation</b>	<b>Simple organisation</b>
<b>North</b>				
Netherlands	64,0	17,2	5,3	13,5
Denmark	60,0	21,9	6,8	11,3
Sweden	52,6	18,5	7,1	21,7
Finland	47,8	27,6	12,5	12,1
<b>Centre</b>				
Austria	47,5	21,5	13,1	18,0
Germany	44,3	19,6	14,3	21,9
Luxemb.	42,8	25,4	11,9	20,0
Belgium	38,9	25,1	13,9	22,1
France	38,0	33,3	11,1	17,7
<b>West</b>				
United Kingdom	34,8	40,6	10,9	13,7
Ireland	24,0	37,8	20,7	17,6
<b>South</b>				
Italy	30,0	23,6	20,9	25,4
Portugal	26,1	28,1	23,0	22,8
Spain	20,1	38,8	18,5	22,5
Greece	18,7	25,6	28,0	27,7
EU-15	39,1	28,2	13,6	19,1

Source : Adapted version based on Lorenz and Valeyre (2006)

Table 4 indicates unequal access to learning between different parts of Europe. The three Nordic countries, together with Netherlands, have few taylorist jobs left in the economy while a majority of employees operate in jobs that are demanding both in terms of skills and in terms of autonomy.<sup>6</sup>

In the next sub-section that draws upon recent work by Lorenz (2007), we take a closer look at how the national learning modes relate to national patterns of education. Here we will find that on the job training and vocational training is a fundamental prerequisite for developing discretionary learning – much more so than the training of science graduates.

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<sup>6</sup> Lorenz has for the sake of this memo made a similar analysis for 2000 that includes 28 countries, including Norway – see Appendix A by Lorenz. Here Sweden comes out as the country with the biggest share of Discretionary learning followed by Denmark and Norway, with remarkably similar patterns of work organization and learning.

### 5.3 Education and training for learning organizations

Since discretionary learning depends on the capacity of employees to undertake complex problem-solving tasks it can be expected that nations with a high frequency of these forms will have made substantial investments in the education and training. In what follows we compare tertiary education in universities and other institutions of higher education with the continuing vocational training offered by enterprises.

Tertiary education develops both problem-solving skills and formal and transferable technical and scientific skills. While most of the qualifications acquired through third-level education will be relatively general and hence transferable on the labor market, the qualifications an employee acquires through continuing vocational training will be more firm specific. Some of this training will be designed to renew employees' technical skills and knowledge in order to respond to the firm's requirements in terms of on-going product and process innovation.

Diagram 1: Discretionary learning and tertiary education

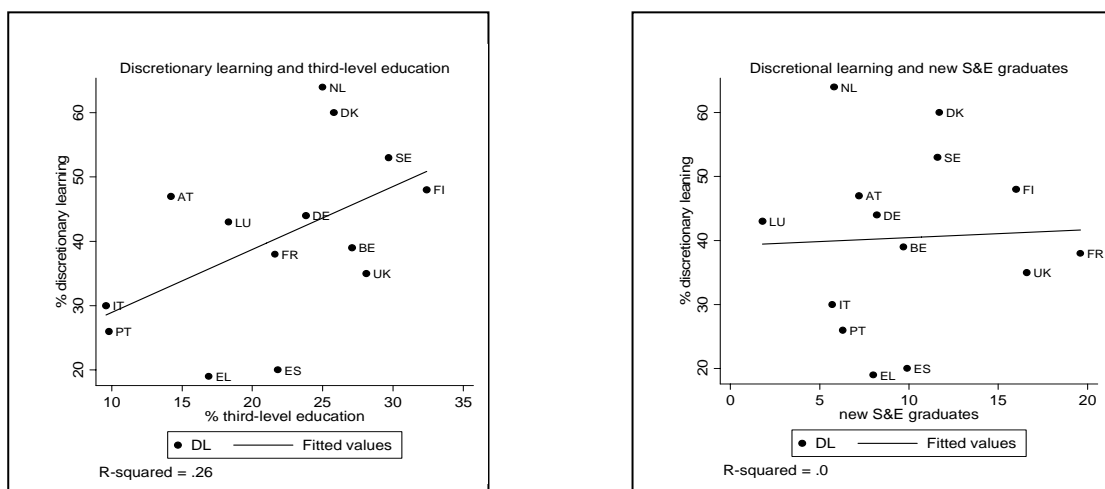


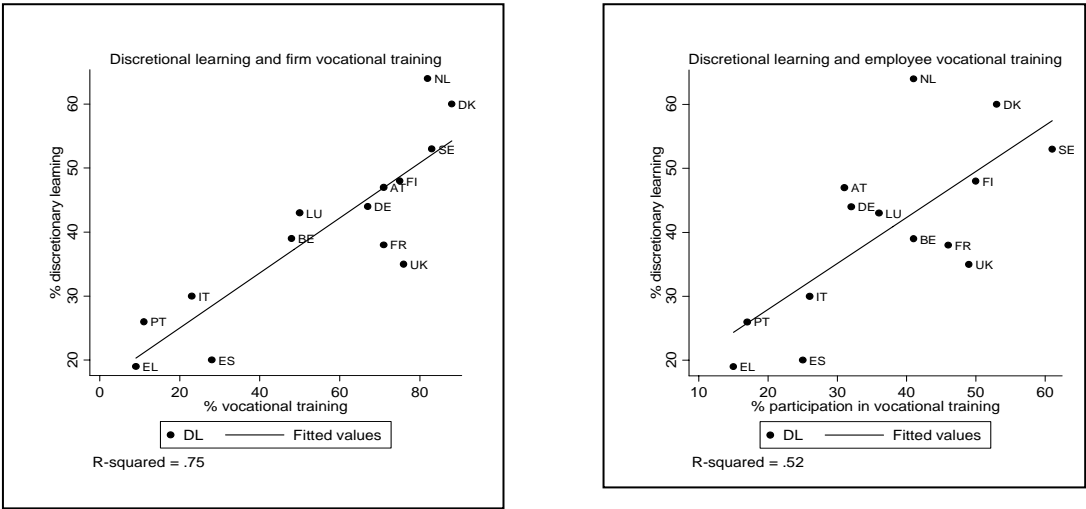
Diagram 1 shows the correlations between the frequency of the discretionary learning forms and two of the four measures of human resources for innovation used in Trendchart's innovation benchmarking exercise: the proportion of the population with third-level education and the number of science and engineering graduate since 1993 as a percentage of the population aged 20-29 years in 2000.

The results show a modest positive correlation (R-squared = .26) between the discretionary learning forms and the percent of the population with third level education, and no discernible

correlation between the discretionary learning forms and the measure of the importance of new science and engineering graduates.

The second diagram shows that there are fairly strong positive correlations (R-squared = .75 and .52 respectively) between the frequency of the discretionary learning forms and two measures of firms' investments in continuing vocational training: the percentage of all firms offering such training and the participants in continuing vocational education as a percent of employees in all enterprises. The results suggest that these forms of firm-specific training are key complementary resources in the development of the firm's capacity for knowledge exploration and innovation. The diagram also points to a strong north/south divide within Europe. The Nordic countries are characterized by relatively high levels of vocational training and by high level use of the discretionary learning forms. This may be seen as one of the common characteristics that contribute to their relative success in the learning economy.

Diagram 2: Discretionary learning and employee vocational training



These results indicate that national educational systems where the emphasis is on the formal training of scientists and engineers while neglecting the broader forms of vocational training may be vulnerable in the context of the learning economy. The more drastic the status difference and distinction between theory and practice in education programs the more difficult it will be to install participatory learning in the private sector. The strong element of vocational training in the Nordic countries contributes to engaging workers more actively in processes of change.

#### *5.4 The role of universities in the innovation system*

When it comes to link universities to economic development the main emphasis is currently on how universities may serve industry through direct flows of information from on-going research. To illustrate, in a recent book with the title 'How Universities Promote Economic Growth' edited by World Bank Economists (Yusuf and Nabeshima, 2007) the only dimension covered is the formation of university-industry links related to research. We believe that this narrow agenda where the role of higher education is neglected reflects a biased interpretation of the sources of innovation (as STI-driven) as well as an underestimation of the importance of transmitting tacit knowledge embodied in people (Lundvall 2002; Lundvall 2007).

In some of the Nordic countries the prevailing 'university models' aimed at are the world leading US-universities in the Boston and the San Francisco area, or possibly the universities in Cambridge or Oxford. While this search for academic excellence may seem commendable it is not unproblematic to combine it with intentions to serve domestic industry. It is not realistic to expect front line research to be absorbed by domestic firms and for advanced research there is a need to collaborate with global rather than domestic firms.

The advanced commercial users of the most ambitious science and technology breakthroughs are thus most often located abroad rather than in the domestic economy. The most important transmission of advanced knowledge relevant for domestic firms takes place as graduates move into industry. *Universities' most important contribution to innovation in the domestic economy remains their formation of graduates with a good problem-solving capacity.* This view is widely shared among innovation scholars (see for instance the report from Salter et al, 2000).

The strong emphasis policy makers and university administrators put on a separate 'third mission' as compared to the much lower attention they give to reforming 'ordinary education' is highly problematic since it results in a neglect of the substantial gains that could be achieved by modernizing the education system. Especially in the fields of engineering and management such educational reforms would have as one central element to deepen and widen the network relationships between university and industry.<sup>7</sup>

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<sup>7</sup> The reason that such reforms are neglected may reflect that they are both more difficult to realize and less visible for the public. They need to take place at the core of the university function and they will not have the same symbolic effect as when a minister opens yet another science park

Seen from this perspective there may be a need to consider how well teaching programs prepare students for the transfer and practical use of scientific knowledge. Innovation is a process requiring close interaction between individuals and organization. Therefore, while skills in mathematics and language are fundamental, they need to be combined with the social skills that make it possible to cooperate vertically in hierarchies as well as horizontally with experts with a different educational background.

This implies that the teaching at the universities needs to be adjusted in order to prepare the students for communication and co-operation with other categories of workers and experts. The way students study and learn at university affects their social skills and so does the broader cultural context of the university. Traditional learning forms such as mass lectures do not prepare students to use the theory and methods in a real life context and neither does it replicate the kind of learning that is required in a future professional life. In professional life most learning takes place through problem solving, often in a context of collaboration with others with a different background. *Problem-based learning and combining theoretical work with periods of practical work is an obvious response to these problems.*

This also implies that there is a need for a concept and indicators of quality with several dimensions. PISA-tests in mathematics, physics and language capabilities need to be combined with tests of interactive capabilities. A high level of the first type of capability is of limited value for innovation if the level for the second type is low. A principal task for higher education is to contribute to *collective entrepreneurship* – i.e. to general skills supporting an interaction with others resulting in innovation.<sup>8</sup>

### *5.5 Policy implications*

The transition to a learning economy has important *implications for education*. The most obvious is that the education system needs to give attention to *enhancing the learning capacity* of students. This does not conflict with teaching basic tools and complex bodies of

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<sup>8</sup> In this section on education we have not referred to the ‘human capital’ literature. The reason is that much of this literature is based upon rates of return on human capital calculated assuming general equilibrium. As argued by Schultz (1975) the rate of return on investment in human capital will more than anything else reflect the ‘degree of disequilibrium’. If this is correct it is not logically satisfactory to make calculations assuming the reign of equilibrium.

theory. But it implies that the way teachers teach and the way students learn becomes crucial since the methods used affect the future learning capability of the student. In the last subsection above we developed this argument further in a critical and policy oriented discussion of the role of the university in the innovation system.

A second major implication is that education institutions need to be ready to support *continuous and life-long learning*. Especially in fast moving fields of knowledge there is a need to give regular and frequent opportunities for experts to renew their professional knowledge. The current boom in MBA and MPA programs may be seen as indicating the growing insight among individuals and in management that continuously renewing competences is of great importance. But so far they tend to operate mainly in relation to management functions. Similar programs are needed in other areas where effective demand is less strong.

Finally, rapid change in science and technology and the need to move quickly from invention to innovation presents a strong argument for keeping a reasonably *close connection between education and research* especially in higher education. Teachers who have little or obsolete knowledge about what is going on in current research are not helpful when it comes to giving students useful insights in dynamic knowledge fields.

## **6. Social capital, trust and the egalitarian Nordic model**

According to standard economic analysis Nordic countries should not perform very well in a global context where knowledge and innovation is a key to economic success. One of the few clear conclusions of new growth theory is that small scale of a system should be a handicap and it is only recently that firms in Denmark, Finland and Norway have increased the R&D-effort. The small scale should be a handicap both because there are scale economies in the production of new knowledge in some of the so-called high technology fields. But it should be a handicap also because it is so much less expensive to apply knowledge than it is to create knowledge. In this section we use the conceptual ideas developed above to demystify this paradox.

At the core of our analysis has been the importance of tacit knowledge and experience based learning. Most interesting forms of learning take place as an interaction between people. The master interacts with the apprentice. Within the business organization interaction among specialized experts and across departments is a prerequisite for successful innovation. When it comes to implement innovation a close interaction between workers and managers is crucial

for success. Firms that interact with customers, suppliers and knowledge institutions are more successful in terms of innovation than those that operate in isolation (Rothwell 1977; Rosenberg 1982; Lundvall 1985).

How people interact and with whom will reflect the society in which they live and the education systems that has shaped them. We will argue that in the Nordic countries social capital and trust are fundamental resources that make their national systems strong in terms of incremental innovation, absorption of knowledge produced elsewhere and rapid adaptation. First we discuss the role of the welfare state and how it can be seen as contributing to broad participation in processes of change. Second we demonstrate that the level of trust and the level of income equality is highest in the Nordic countries (and Netherlands). Third we show how a more fundamental and dynamic dimension of equality – the access to on the job learning – is also strongest in the Nordic countries and Netherlands.<sup>9</sup>

### *6.1 Welfare states and economic performance*

Welfare states may be defined as countries where the public sector is heavily engaged in provision of basic services such as education and health. Welfare states will also typically be characterized by social security arrangements with the public sector as last resource guaranteeing the social standard of citizens when exposed to unemployment, health problems and old age. Finally welfare states will interfere in income distribution through taxes and subsidies aiming at reducing the degree of income inequality.

According to the analysis of standard neo-classical economic theory ambitious welfare states should not be expected to perform well. Here it is assumed that, in the absence of market failure, perfect competition will result in an efficient allocation of resources. Seen from this point of view most of the public sector activities characterizing the welfare state are alien and unnecessary.

The pro-market bias of standard economics is reflected in policy advice offered by international organizations such as the OECD and the World Bank. Much of the advice on economic policy coming from the European Commission has also, at least until recently, pointed in the same direction – often with lofty references to the need for ‘structural reform’

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<sup>9</sup> In appendix A present a bold theory about economic development where social capital is linked to the division of labor and the division of labor is linked to interactive learning and innovation.

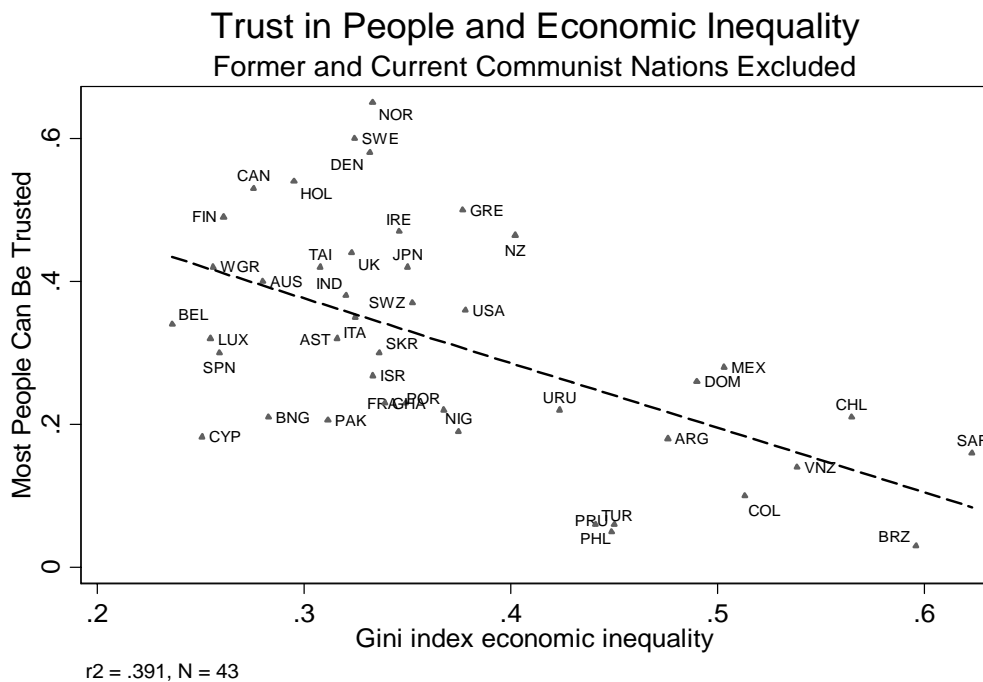
in member countries. Big public expenditure, high and progressive tax rates and generous public social schemes have been characterized as hampering growth and in countries with ambitious welfare policies, more market and more individual entrepreneurship have been hailed as keys to higher economic growth. This general message has been reinforced through references to the threat coming from globalization. It has been argued that, *ceteris paribus*, capital will move out of the ambitious welfare states and move to national systems with small government and low taxes.

However, globalization does not affect welfare states uniformly, and actually the Scandinavian welfare model seems to have prospered in the context of globalization. Since 1990, the Scandinavian countries have outperformed not only Continental European countries on employment, economic growth and labor productivity but also the neo-liberal models of the UK and the US. For instance, from 1990 to 2005, the average annual growth in labour productivity in the private sector was 2.6 per cent in the Nordic Countries, as against 1.3 per cent in the entire Euro zone, 2.0 per cent in the USA and 2.1 per cent in UK. On the World Economic Forum's 2005 ranking of all countries according to international competitiveness, the Scandinavian countries occupied five of the upper nine positions. A key to understand this relative success is social capital and trust.

### *6.2 Social capital and Trust as key elements in the Nordic model*

In the US-dominated literature social capital has been presented as rooted in civil society and the frequency of participation in civic activities has been used as indicator of 'social capital'. It has been argued that big government and big public sectors undermine civil society and thereby also social capital. The Scandinavian experience shows that the growth in the welfare state has not reduced the participation in civic organizations and that levels of trust are much higher in the Scandinavian countries than in countries with smaller states. Especially there is a strong correlation between general (rather than selective) social welfare programs and generalized trust. Social capital is a somewhat amorphous concept and it has referred both to individual access to social resources and to societal characteristics affecting social interaction. Here we define it as 'the willingness and capability of citizens to make commitments to each other, collaborate with each others and trust each other in processes of exchange *and* interactive learning'.

Diagram 3: Trust in people and economic equality



In diagram 3 the four Nordic countries stand out both in terms of the degree of trust and in terms of economic equality together with Netherlands and Canada. (Diagram 3 originates from a power point presentation by Bo Rothstein and has been downloaded from the internet).

According to the European Social Survey trust among agents seems to be consistently higher in the Nordic countries than in most other countries (see Table 5) and combined with the small size of the system it results in a high degree of dense *interaction* among agents both within and across organizations.

This gives rise not only to low transaction costs but more importantly it facilitates processes of interactive learning where new insights about technologies and good organizational practices are diffused rapidly both within organizations and across organizational borders. The most important impact of high degrees of trust is *high learning benefits*. Low social distance between managers and workers and willingness to trust partners are key elements behind the relative success of the Nordic countries.

While the innovation systems in the Nordic countries are handicapped in the production of codified knowledge because of negative scale effects they have been highly successful in terms of learning by doing, learning by using and learning by interacting.

Table 5: Index of trust in 14 European countries based upon the European Social Survey

	2002	2004	2006
Danmark	7,2	7,0	7,2
Finland	6,7	6,7	6,7
Norway	6,8	6,8	6,9
Sweden	6,4	6,3	6,5
France	5,0	5,1	5,1
UK	5,3	5,3	5,6
Germany	5,2	5,2	5,2
Netherlands	5,9	6,0	6,0
Belgium	5,2	5,2	5,4
Ireland	5,7	6,0	5,6
Austria	5,3	5,5	5,4
Spain	5,0	5,0	5,3
Hungary	4,5	4,3	4,5
Switzerland	5,9	6,1	6,1

In the European Social Survey, respondents are asked the two questions (Do you trust most people? and Do you think that most people would take advantage of you if they got the chance?) with degrees between 1-10. The index above gives the average response.

### *6.3 Degree of inequality in access to organizational learning in Europe*

An egalitarian income distribution might not be the most important dimension of social equality it is combined with growing gaps in competence between the skilled and the low skilled workers it might result in underemployment of the low-skilled. From a more theoretical welfare point of view Sen (2000) argues that inequality should be related more to capabilities than to the static distribution of income. The data referred to above on organizational models of learning in different European countries makes it possible to find indicators of such more adequate measures of inequality. In table 6 we present an indicator for the social distribution of workplace learning opportunities. We distinguish between ‘workers’ and ‘managers’ and we compare their access to discretionary learning in different national systems.<sup>10</sup>

Table 6 shows that employees at the high end of the professional hierarchy have more easy access to jobs involving discretionary learning. This is true for all the countries listed.

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<sup>10</sup> The class of managers includes not only top and middle management but also professionals and technicians (ISCO major groups 1, 2 and 3) The worker category includes clerks, service and sales workers as well as craft, plant and machine operators and unskilled occupations (ISCO major groups 4 through 9).

Table 6: National Differences in Organisational Models (percent of employees by organisational class)				
	Discretionary learning	Share of managers in discretionary learning	Share of workers in discretionary learning	Learning Inequality index*
<b>North</b>				
Netherlands	64,0	81.6	51.1	37.3
Denmark	60,0	85.0	56.2	35.9
Sweden	52,6	76.4	38.2	50.3
Finland	47,8	62.0	38.5	37.9
Austria	47,5	74.1	44.6	39.9
<b>Centre</b>				
Germany	44,3	65.4	36.8	43.8
Luxemb.	42,8	70.3	33.1	52.9
Belgium	38,9	65.7	30.8	53.1
France	38,0	66.5	25.4	61.9
<b>West</b>				
UK	34,8	58.9	20.1	65.9
Ireland	24,0	46.7	16.4	64.9
<b>South</b>				
Italy	30,0	63.7	20.8	67.3
Portugal	26,1	59.0	18.2	69.2
Spain	20,1	52.4	19.1	63.5
Greece	18,7	40.4	17.0	57.9

Source: Lundvall, Rasmussen and Lorenz (2008)

\* The index is constructed by dividing the share of 'workers' engaged in discretionary learning by the share of 'managers' engaged in discretionary learning and subtracting the resulting percentage from 100. If the share of workers and managers was the same, the index would equal 0, and if the share of workers was 0 the index would equal 100.

But it is also noteworthy that the data indicate that the inequality in access to learning is quite different in different countries. In the Nordic countries and Netherlands the inequality in the distribution of learning opportunities is moderate while it is very substantial in the less developed south. For instance, the proportion of the management category engaged in discretionary learning in Portugal is almost as high as in Finland (62% in Finland and 59% in Portugal), but the proportion of workers engaged in discretionary learning is much lower in Portugal (18.2% versus 38.2%).

This pattern indicates the Nordic countries are egalitarian not only in terms of income distribution. Also when it comes to access to learning the distribution is more equal than elsewhere. The combination of welfare states offering some kind of basic security, equal income distribution and low social distance is reflected in high degrees of trust and in a broad participation in change. While there are tendencies toward polarization in the current context also in the Nordic countries they still benefit from a kind of social capital that supports dynamic economic efficiency

So while it might be true that higher education fosters people who are successful as equilibrators and innovators at least in the Nordic countries it seems to be when those people interact with broader segments of the workforce in promoting or coping with change that the innovation system as a whole turns out to be most efficient.

#### *6.4 Policy implications*

Traditionally the focus of innovation policy has been on strengthening the R&D-effort, strengthening the link between universities and industry and increasing the numbers and the formal qualifications of engineers and scientists (Lundvall and Borras 2005). Such efforts are useful and necessary in the current era. But if they stand alone they cannot be expected to constitute a strong innovation system. It is necessary to take a broader and more systemic approach to competence building.

### **7. Summing up and broadening the perspective**

This memo is built up around the assumption that innovation and competence building policy may become more balanced and adequate through a better understanding of the tacit dimension of knowledge and experience-based dimension of learning. We have also argued that the relative success of the small Nordic countries is rooted in social capital and trust contributing not only to low transaction costs but also to dynamic effects reflecting a highly developed division of labour and high benefits from interactive learning within and across organisational borders.

From this point of view we have criticized strategies that focus almost exclusively on promoting science-based learning in what is regarded as high-technology sectors. We have also raised questions about the current drive to transfer scientific knowledge directly from academic research to the business sector and the tendency toward commercialisation of universities that it involves. By defining the role of graduates in innovation processes we have argued that much more focus should be on higher education and that the flow of graduates to industry constitutes the single most important transmission mechanism.

We see the development of policies aiming at supporting DUI-learning as a major task ahead that should involve an interaction between policy makers on the one hand and innovation scholars, management and employees on the other. There is a need for new indicators, data sets and case studies. Comparative approaches where several small national systems are

compared (Nordic countries, Netherlands and Ireland for instance) may be the most relevant strategy.

It is important to note that historical patterns and strengths change over time. In the Nordic countries stronger element of science-based learning in more traditional sectors is necessary for the upgrading of activities exposed to global competition. The low proportion of low-skilled jobs left in the Nordic countries will become even smaller and there is a need for a 'new new deal' where the focus is upon supporting competence-building among those who are weak in the labor market – i.e. workers with low skills and workers with a different ethnic background.

So far the focus has been on capability to innovate and adapt in a rapidly changing environment in the small Nordic Countries with focus on absorbing new technology from abroad. The policies involved are oriented mainly toward market repair and support. The new challenge for innovation that relates to energy and environmental sustainability requires more ambitious policies (Smith 2008).

The environmental threats call for radical trans-disciplinary and multi-technological breakthroughs and they need to be realistically anchored in an understanding of the role of institutional barriers as well as social movements and interest groups (Jamison and Østby 1997). In this context it is useful to think in terms of *building new technological systems* seen as combinations of interrelated sectors and firms, institutions and regulations (Carlsson and Stankiewicz 1991). It is a major challenge for the Nordic countries to find ways through specialized efforts to contribute to the building of such systems. Here there will be a need for more ambitious domestic policies as well as for far-reaching international collaboration.

In the case of environmental innovation co-ordinating the following three policy elements may be crucial for success:

- a) Creating markets for green products through establishing standards in an interaction between users and producers and procurement policies activating private and public users.
- b) Strengthening institutes in charge measuring and evaluating the crucial parameters related to the environment. Building new institutions for training and research.
- c) Strengthening the links between environmental policy, innovation policy and general economic policy.

## **Appendix A: Update of Work organization clustering in Europe EU-28 year 2000**

By Edward Lorenz, University of Nice

### **Work organisation variables**

In order to characterise the adoption across the EU-27 and Norway of the main forms of work organisation identified in these literatures, the following 15 active variables are used in the multiple correspondence and cluster analyses:

- a 3-level variable measuring the use of teamwork (twdt), distinguishing autonomous teamwork (with decisions on division on tasks by team members), non-autonomous teamwork (without decision on division on tasks by team members), and no teamwork;
- a binary variable measuring task rotation (rot);
- two binary variables measuring autonomy in work: autonomy in the methods used (autm) and autonomy in the pace or rate at which work is carried out (auts);
- four binary variables measuring the factors or constraints which determine the pace or rate of work: ‘automatic’ constraints linked to the rate as which equipment is operated or a product is displaced in the production flow (caut); norm-based constraints linked to numerical production targets or performance targets (cnor); ‘hierarchical’ constraints linked to the direct control which is exercised by ones immediate superiors (chie); and ‘horizontal’ constraints linked to way one person’s work rate is dependent on the work of his or her colleagues (chor);
- a binary variable measuring repetitiveness of tasks (less than a minute) (rep);
- a binary variable measuring the perceived task monotony (mono);
- two binary variables measuring the way quality is controlled: (qn) which corresponds to the use of precise quality standards; and (qe) which corresponds to self assessment of quality of work;
- a binary variable measuring the complexity of tasks (cplx);
- and two binary variables measuring learning dynamics in work: (lrn) which corresponds to whether the individual learns new things in his or her work; and (pbs) which corresponds to whether the work requires problem-solving activity.

**Table 1.3: Work organisation across the classes: EU-27 and Norway**

		Classes of work organisation forms				All
		Discretionary learning	Lean production	Taylorist	Traditional or simple	
Learning new things		87.7	89.3	38.1	27.1	68.3
Problem solving activities		96.4	92.7	53.2	47.5	78.9
Complexity		79.1	83.7	34.8	18.1	61.4
Monotony		21.9	61.3	73.9	36.7	44.5
Repetitiveness of tasks		10.2	41.5	40.4	17.7	25.3
Task rotation		41.2	78.8	40.8	27.8	48.5
Teamwork	Members decide on task division	33.8	47.9	13.2	19.0	31.0
	Members do not decide on task division	24.9	40.4	45.6	17.5	31.4
Quality	Self assessment	81.7	91.5	56.9	25.5	69.9
	Norms	77.7	95.7	91.8	35.3	77.8
Autonomy in methods		88.8	66.4	9.8	45.4	60.6
Autonomy in speed or rate of work		87.7	66.3	20.8	53.6	63.6
Work pace constraints	Automatic	3.8	46.4	59.9	5.9	25.8
	Norm-based	42.2	76.1	73.8	14.6	52.2
	Hierarchical	24.6	65.7	69.7	30.0	44.6
	Horizontal	36.0	85.0	64.2	24.8	52.0
Sample		38,2	25,7	19,0	17.1	100.0

Table 3.1: Differences between countries in forms of work organisation  
(weighted percent of employees by organisational class)

	Classes of work organisation			
	Discretionary learning	Lean production	Taylorist	Traditional or simple
Belgium	41.2	25.2	16.8	16.9
Czech Republic	30.2	25.1	22.8	21.9
Denmark	54.1	28.4	7.9	9.6
Germany	43.3	19.8	18.3	18.6
Estonia	40.8	32.7	11.4	15.1
Greece	22.9	28.9	24.5	23.6
Spain	20.6	24.9	26.3	28.2
France	46.7	24.8	17.6	10.9
Ireland	42.3	26.8	10.9	20.1
Italy	38.2	24.4	21.4	16.0
Cyprus	27.9	24.7	21.6	25.8
Latvia	35.2	32.6	17.1	15.1
Lithuania	24.5	30.8	22.0	22.7
Luxembourg	44.2	29.0	13.1	13.7
Hungary	39.6	16.4	23.9	20.1
Malta	47.0	34.3	10.6	8.1
Netherlands	52.8	22.7	11.9	12.6
Austria	48.1	21.4	17.9	12.6
Poland	33.5	31.3	20.0	15.2
Portugal	24.8	30.3	32.1	12.9
Slovenia	34.0	31.0	16.9	18.1
Slovakia	28.9	19.0	34.3	17.8
Finland	44.9	30.9	11.3	12.9
Sweden	67.2	14.9	7.1	10.8
UK	30.3	33.3	16.7	19.7
Bulgaria	20.3	28.1	30.2	21.3
Romania	24.3	32.5	28.2	15.0
Norway	55.6	28.2	6.0	10.2
All	38,2	25,7	19,0	17.1

<b>Regional patterns</b>	Discretionary learning	Lean production	Taylorist	Traditional or simple
Nordic Countries				
Sweden	67.2	14.9	7.1	10.8
Norway	55.6	28.2	6.0	10.2
Denmark	54.1	28.4	7.9	9.6
Finland	44.9	30.9	11.3	12.9
Continental Countries				
Netherlands	52.8	22.7	11.9	12.6
Austria	48.1	21.4	17.9	12.6
France	46.7	24.8	17.6	10.9
Luxembourg	44.2	29.0	13.1	13.7
Germany	43.3	19.8	18.3	18.6
Belgium	41.2	25.2	16.8	16.9
Anglosaxon countries				
Ireland	42.3	26.8	10.9	20.1
UK	30.3	33.3	16.7	19.7
Mediterranean countries				
Malta	47.0	34.3	10.6	8.1
Italy	38.2	24.4	21.4	16.0
Portugal	24.8	30.3	32.1	12.9
Cyprus	27.9	24.7	21.6	25.8
Greece	22.9	28.9	24.5	23.6
Spain	20.6	24.9	26.3	28.2
Former socialist countries				
Estonia	40.8	32.7	11.4	15.1
Latvia	35.2	32.6	17.1	15.1
Lithuania	24.5	30.8	22.0	22.7
Hungary	39.6	16.4	23.9	20.1
Czech Republic	30.2	25.1	22.8	21.9
Poland	33.5	31.3	20.0	15.2
Slovenia	34.0	31.0	16.9	18.1
Slovakia	28.9	19.0	34.3	17.8
Bulgaria	20.3	28.1	30.2	21.3
Romania	24.3	32.5	28.2	15.0
All	38,2	25,7	19,0	17.1

## **Appendix B: A dynamic version of The Wealth of Nations**

What follows in this appendix is very much in the spirit of Adam Smith (1776/1904) since it links economic development to the deepening and the widening of the division of labor. We add to the analysis a social dimension and the dynamics of interactive learning. It may be seen as an attempt to bring his analytical framework up to date by taking into account the speed up of change and the increasing importance of knowledge creation and learning ( see also Lundvall 2006).

Specialization has two dimensions: specialization within an organization and specialization between organizations. The more developed internal specialization makes it possible to reap static economies of scale within the organization. A similar static effect emanates from increasing the vertical division of labor among organizations. A single firm specialized in producer goods – components, equipment and systems – instead of serving a user within the same organization – may serve several external clients and thereby obtain scale economies in production.

Williamson (1975) has had a major impact on the understanding of industrial organization and especially on the analysis of vertical integration and disintegration. Starting from Williamson's analysis it is a paradox that product innovation (innovations addressing the market) is a frequent phenomenon – at least as frequent as process innovation (Lundvall 1985). One way to solve the paradox is to introduce the idea of 'organised markets' and different mechanisms (such as formation of trust) that might limit opportunism in such markets (Lundvall 1992).

The separation of users from producers into two distinct organizations actually might enhance interactive learning. If a producer integrates with a user, or the other way around, the integrated couple tends to become less attractive as partners for interaction, information exchange and learning seen from the viewpoint of the remaining independent users or producers. The independent units have very good reasons to be wary about the self-interest of the integrated units and be reluctant to share information about what they have learnt from doing and using.

From the view-point of the whole economy *the learning by interacting has the effect of transforming local learning into general knowledge embodied in for instance new machinery, new components, new software-systems or even new business solutions.*

## *Social capital and interactive learning*

In a brief essay developed on the basis of his Adam Smith lecture 1994 Douglass North introduces a parallel discussion (North 1996). His essay confronts with each other the gains from increasing division of labor with the costs to make the system work. He identifies a ‘transaction sector’ and refers to data showing that already 1970 as much as 45% of GNP in the US could be defined as ‘transaction costs’.

North does not make a clear distinction between internal and external ‘transaction costs’ and he tends to see all government expenditure as transaction costs. In the beginning of his essay he refers to ‘human learning, the most important source of long run economic change,’ but in the rest of the paper institutions are discussed not in terms of how they affect learning but instead he discusses their impact upon transaction costs.

His observations that it is more or less difficult to establish ‘efficient markets’ in different national economies and that the concept ‘social capital’ may be seen as opening up a new way of tackling this issue are useful for our purpose. But we use the adjective ‘efficient’ with a different meaning. North says that ‘the key to efficient markets are institutions that result in low costs of transacting’. Here we emphasize that (in the learning economy) dynamic efficiency needs to be taken into account and dynamic efficiency has to do with how far *institutions support learning* within and between organizations.

There might be overlap between institutional forms that bring down transaction costs and forms that stimulate learning – the presence of trust and the absence of opportunism are obvious examples. But they are certainly not identical. For instance a restrictive intellectual property right regime may reduce transaction costs while at the same time reducing benefits from learning by interacting.

One obvious case where the two conceptualizations of efficiency deviate is when producers and professional users are engaged in a process of interactive learning in connection with product innovation. Here you might reduce transaction costs by vertical integration. But by doing so you would reduce the contribution from interactive learning to technical progress both on the user and the producer side.

North makes the point that the vertical division of labor will be affected by ‘social capital’. It is a somewhat amorphous concept but it certainly points in the right direction. Here I define it as ‘the willingness and capability of citizens to make commitments to each other, collaborate with each others and trust each other in processes of exchange *and* interactive learning’.

Defined in this way it is true that a society rich in terms of ‘social capital’ would operate with a more developed vertical division of labor – including more organizational borders cutting through the production chains. Such a society would be more successful in terms of net wealth creation because its interactive learning would be based on more diversity and local learning would be more widely generalized and diffused more widely in the economy.

The Nordic countries have performed well in spite of small size and limited investment in the formal knowledge base. This is paradoxical especially in a ‘knowledge-based’ world economy. Big countries should do better than small ones since the costs of creating new knowledge is so much higher than the costs of reproducing it. We would argue that the Nordic Innovation Systems have overcome this handicap through mechanisms referred to in this appendix. High levels of trust and low levels of social distance have made it possible to extend the division of labor and establish strong learning economies.

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