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DRUID Working Paper No. 99-12

**Extending and Deepening the Analysis
of Innovation Systems - with Emperical
Illustrations from the DISCO-project**

by

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October 1999

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Abstract

Traditionally innovation system have been analysed either as rooted in the R&D-system or the production system. This paper suggests a broader approach to national innovation systems and analyse these as rooted in constellation of a national production structure and human resource development institutions. The argument is linked both to the literature on innovation systems and an empirical account of the Danish innovation system (the DISKO-project) and the economy in general. It is argued that change of the innovation and production system is difficult without a reform of the human resource development system as the dynamics of these two dimensions are closely connected. Results from the DISKO-project are used to illustrate the new analytical and political issues emanating from such a shift in perspective. On the one hand it is shown that the general economic climate in terms of the transformation pressure and the intensity of competition has a major impact on what the firm does in terms of technical innovation and organisational change. On the other hand it is demonstrated how the behaviour of individual firms affect aggregate employment and specifically the employment opportunities of unskilled workers.

It is argued that the broader approach to the analysis of innovation systems also calls for a broader policy approach. Innovation is affected by other types of policy than industrial policy and a sharp division between macro-economic and competition policy on the one hand and education, labour market and innovation policy on the other hand is shown to be problematic.

Keywords: innovation systems, human resources, transformation pressure, organisational change

JEL: 030, 031, 324

ISBN(87-7873-082-1)

Introduction

The concept of national systems of innovation goes back to Friedrich List who criticised what he labeled as ‘the cosmopolitan’ approach of Adam Smith as too focused on competition and resource allocation to the neglect of the development of productive forces (List 1841). The analysis of national systems developed by List took into account a wide set of national institutions including those engaged in education and training as well as infrastructures such as networks for transportation of people and commodities (Freeman 1995).

The modern revival of the concept some 12-15 years ago gave rise to different more or less broad (often implicit) definitions of innovation systems. The US-approach (Nelson 1988) linked the concept mainly to hi tech- industries and put the interaction between firms, the university system and national technology policy at the centre of the analysis. Freeman (1987) introduced a broader perspective that took into account national specificities in the organization of firms – he emphasised for instance how Japanese firms increasingly used ‘the factory as a laboratory’. The Aalborg approach (Lundvall 1985 and Andersen&Lundvall 1988) was inspired by the analysis of national production systems pursued by the French structuralist school in Grenoble. It looked at national systems of innovation as rooted in the production system and it also emphasised the institutional dimension, where institutions were defined theoretically either as norms and rules or as materialised in the form of organisations (Johnson 1988). Porter (1990) brought in regimes of competition as important dimensions of national systems.

Looking at some of the major recent contributions on innovation systems (Freeman 1987, Porter 1990, Lundvall (ed.) 1992, Nelson (ed.) 1993 and Edquist (ed.) 1997) the focus remains on the production and innovation system while much less attention is given to the part of the economy engaged in the development of human resources. Going back to List and, not least, to Marshall, who emphasised that regional competence was rooted in the workforce, this remains a rather partial perspective. Especially in a period when it is recognized that more and more of economic dynamics depend on the creation, dissemination and use of knowledge, it is natural to put a stronger focus on the human resource dimension.

The obvious alternative is to give a stronger emphasis to the fact that education systems and labour markets are nationally constituted and play a key role in competence building and in shaping the foundation for innovation processes. And to recognize that there are national specificities in the formation of skills and in the national labour dynamics as well as other economic and cultural barriers to the free movement of labour across national borders. There are important changes taking place that increase the international mobility of highly skilled labour but there is little doubt that ‘human capital’ and labour remains the least mobile of the resources used in the production process.

Starting from a different tradition that, historically, has put less emphasis on technical innovation and more on macro-economic dynamics, regulation school economists have been among the first to introduce the human resource dimension when pursuing comparative analyses of national systems (Boyer, Amable&Barré 1997). In their factor

analysis of international differences, four out of the nine indicators used are related to the human dimension:

Table 1: System characteristics developed into indicators used to classify 12 national systems of innovation in Boyer, Amable&Barré (1997):

- | |
|---|
| <ul style="list-style-type: none"> - Scientific specialization - Technological specialization - <i>Implementation of new production model</i> - <i>Labor market flexibility</i> - <i>Skill level</i> - <i>Education achievements</i> - Costs of capital - Sophistication of capital market - Macroeconomic performance |
|---|

Also, in the parallel work on ‘national business systems’ pursued by Whitley and others there is a strong emphasis on national specificities in human resource development systems and labour markets (referred to as the ‘labour system’ in Whitley 1996).

Innovation systems – three alternative perspectives

We can thus identify at least three different ways of delimiting the innovation system. The first is the innovation system as *rooted in the R&D-system*, the second is the innovation system as *rooted in the production system* and the third is the innovation system as *rooted in the production and human resource development system*.

In 1995 when designing the project on the Danish innovation system to be reported below (DISKO) we had to make a choice between these different delimitations of the system. We chose the last and broadest alternative. There were three reasons for this choice.

The first reason had to do with our before hand knowledge about the characteristics of the Danish economy. Denmark is weak in science based activities. Few radical innovations take place in Denmark. Most of the R&D-content in Danish products comes from abroad – much of it as embodied in imported products. We also knew from earlier research that a majority of Danish firms are regularly involved in incremental innovation and in the rapid introduction of new process technology. It is also interesting to note that Denmark in spite of its low-tech specialisation is among the countries in the world with the highest GNP per capita. We concluded that to focus on the rather small part of the economy engaged in formal R&D-activities would give very limited insights regarding the growth potential of the economy. We believe that this argument is valid for other smaller countries and as well for developing countries. It may perhaps be argued that the ‘made in America’ study (Dertoutzos et al, 1989) and the made in France study (Taddei&Coriat 1993) in spite of their weak emphasis on innovation indirectly have demonstrated that this wider perspective has a relevance even for big countries.

The second reason for taking the broader view had to do with the basic assumption about the 'learning economy' developed in connection with the collective Aalborg book on innovation systems (Lundvall 1992). In Dalum, Johnson & Lundvall (1992) and in Lundvall&Johnson (1994) we argued that the last decade had witnessed a change in the mode of competition that implied that interactive learning (and forgetting) had become the most important process for determining the position of individuals, firms, regions and countries in competition. This hypothesis pointed to the need to give stronger emphasis to the analysis of the development of human and organisational capabilities. In the 1992-book and elsewhere we had signalled the importance of learning but said very little about who learnt what, and why, and it remained somewhat unclear exactly how learning was related to the process of innovation. In order to open up these black boxes it was useful to link competence building explicitly to innovation and industrial dynamics.

The third reason had to do with the fact that empirical studies especially at the regional level (see for instance the Ph.D.-dissertations by Gelsing and Jensen) only partially supported the original hypothesis in Lundvall (1985) about innovations systems as primarily rooted in and constituted by inter-firm, user-producer relationships. One obvious alternative was the broader perspective on regional and national systems as constituted by a common knowledge base embedded in local institutions and embodied in people living and working in the region.¹

Limitations of academic specialisation

When designing the Aalborg-book on national systems of innovation (Lundvall ed. 1992) we had planned to have a chapter on the education system but at the end we did not succeed. One major reason why this and most other studies of innovation systems have not taken the broader perspective is the narrow specialisation predominant in socio-economic academic research. Innovation scholars are not experts on labour market and education and those who know a lot about education and labour markets are often not interested in the innovation perspective. To implement the broader view in empirical research calls for research teams with a broader set of expertise than what normally has been gathered around innovation studies. Experts on education, labour market and organisational issues have to be combined with innovation experts in order to cover the whole system. This can only be done in long term and big scale projects where it is possible to combine and, to a certain degree, integrate the different perspectives.

The current funding and academic incentive systems are not well adopted to support this kind of projects. National scientific bodies in charge of funding regard broad cross-disciplinary endeavours with suspicion. Other public agencies and private funds might be more open to engaging in funding this kind of research. But normally they will have problems with the time scale involved since they feel that they need research results tomorrow rather than in a more distant future. European funding of socio-economic research has actually been more open to inter-disciplinary projects but here so much effort has to be used to integrate scholars with different national background that it leaves little time for, at the same time, combining and integrating the ideas of scholars coming from different disciplines.

The DISKO-project involved general economists, business economists and social scientists with an expertise on innovation, human resource management, labour market and education issues and did, to some degree, overcome the barriers mentioned above. It reflects the fact that it came about in a rather unique situation. On the one hand, there was a strong analytical interest in the Ministry of industry and in the Board of Industrial Development (the funding agency) reflecting that earlier research contributions from the IKE-group had proved to be of direct use in the policy process. On the other hand, the culture of Aalborg University and the Department of Business Studies is quite open for joining expertise with different background and, accidentally, at the very time of the project start, it proved possible to gather, in one team, a constellation of scholars with different background.

The alternative of trusting luck would be politically to give such projects a high priority on the national research agendas. Here organisations such as EC and OECD could play a role in supporting such endeavours while emphasising the comparative dimension of the projects.

The organisation of the DISKO-project

The DISKO-project has been divided into four distinct modules each focusing on a specific level of the innovation system:

1. Technical change, organisational change and human resource development within firms (Based on a national survey, on Nordic country comparative survey, on case studies and linking survey results to statistics on labour market dynamics).
2. Product innovation and inter-firm collaboration (Based on national survey, OECD comparative survey and on case studies).
3. Firms' interaction with the knowledge infrastructure and with factor markets (Focus on respectively the finance of innovation, vocational training and interaction with knowledge institutions – each area analysed by combining survey data with case study material or expert interviews).
4. Mapping knowledge intensity and knowledge flows in the whole economy (Patent data, R&D-data and education data were linked to input-output analysis).

Nine research reports – in Danish - from these modules and a number of papers in English (see appendix A) have been published. We expect five Ph.D.-dissertations to make use of the data gathered within DISKO. (Two of the Ph.D.s involved have been fully financed by the ministry of industry and they have spent about 6 out of 30 months working in the Ministry).

There have been more than 20 scholars working on the project (see appendix B). Their work has only partially been financed by the grant from the industrial development board. Most of the grant has been used to establish new data sets through surveys and case studies and through linking the survey data to register data. Some of the most interesting results emanate from this kind of new combination of data sets (see below). In most of the studies we have been able to include service sectors in the analyses and this is another area where the project has produced interesting new insights, for instance regarding sectoral differences in innovative behaviour.

The final report was published in September 1999 in the form of a 'research based policy debate document'. It combines results obtained in the different modules with data from recent OECD-publications and characterises the system and points to major policy challenges. Beginning of September this year the Council of Industrial Development invited Danish expertise in charge of a wide set of sector policies to a conference where some of the recommendations coming out of the project were discussed.

In what follows we briefly summarise a selection of important results from the DISKO-project. First we focus on structural characteristics of the Danish economy and on policy recommendations related to these characteristics. Here we draw upon a combination of empirical analysis as pursued in the different DISKO-modules and especially OECD-material, and the policy recommendations reflect the reasoning in the final report. In the second part of the paper we analyse the macro-micro-macro dynamics of the system basically using data from module 1 in the DISKO-project. Here, the focus is on how the transformation pressure at the macro level affects the behaviour of firms and, vice versa, on how changes at the level of the firm result in changes in aggregate employment and in a shift in demand for unskilled workers for the economy as a whole. A general purpose of the paper is to illustrate the usefulness of studying national innovation systems as rooted in the production and the human resource development system.

Characterising the Danish innovation system in terms of performance and specialisation

Denmark is a rich country with a population working many hours with low and stagnating productivity

The Danish economy has a high GNP per capita but this reflects primarily that the active participation in the formal economy is much higher than in most other European countries. Especially the participation rate of women is very high. The average Danish citizen delivers about 30% more working hours per year than the average European citizen. In spite of this fact the focus in current economic policy debates has been on how to avoid a reduction in the quantitative supply of labour.

Much less has been said about the potential for increasing productivity growth. As compared to other European countries labour productivity is not high in Denmark and, especially in manufacturing and in construction, productivity growth has been stagnating for a longer period. There are no clear explanations of this fact, which points to a need to make a major effort to get a better understanding of the process of productivity growth. This would involve an analysis of macro phenomena. But what is most needed is an effort to look for explanations related to structural change, firm population dynamics and transformations taking place inside firms.²

Denmark is specialised in low technology

It is a fact that Danish export and production is strongly specialised in low-technology products and this fact has been evoked as an explanation of unsatisfactory productivity growth. But there have been few attempts to link the two phenomena together analytically. We find a low technology specialisation in several other small high

income countries but Denmark stands out as an extreme also among those (together with Finland). There are some high technology islands in the Danish economy and especially the sector producing pharmaceuticals (dominated by NOVO) is extreme in its strong connection to science. This results in an (misleading) over all image of Danish patenting as more science based than patenting in other countries.

Denmark is especially successful in the production and export of 'low' and 'low medium' technology goods. This includes food products, furniture and clothing. It has successful niche products in telecommunication (mobile communication) and in process regulation (Danfoss). Within these fields firms are quite successful in absorbing and using technology from abroad including information technology. Incremental product development characterises both the high technology and the low technology firms.

The mode of innovation is highly interactive but not science based

Within firms there is a growing emphasis on the interaction across departments, between colleagues and between management and workers. Danish manufacturing firms interact with customers and suppliers more frequently than firms in other countries.

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

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

Historically most of the academically trained work force has been employed in the public sector. This has gradually been changing through the last decade where especially business services have absorbed a growing proportion of the candidates. But still a big proportion of private firms have no or few academics in their workforce. We can show that there is a positive relationship between the intensity in the use of academic personnel and the probability that firms collaborate with universities.

Policies aiming at upgrading the knowledge-base

In the DISKO research-based policy report we point to different means to increase the proportion of science based, high technology activities. These include extending programmes already established such as the innovation milieu programme aiming at promoting high technology entrepreneurship and the development contract programme combining in the same project firms, universities and technological institutes. They also include a clarification of the division of labour between universities and technological institutes.

Universities need to find forms for strengthening their interaction with firms in certain highly dynamic technological fields without jeopardizing their fundamental role in producing generic knowledge and high quality candidates, while the absorption capacity of technological institutes could be enhanced by allowing them to develop a stronger research base. Attempts to create stronger incentives in order to stimulate job circulation between firms, technological institutes and universities, of the kind practised around Stanford University, are recommended.

But we also argue that such efforts can, at best, change the pattern of specialisation slowly and that it is at least as important to upgrade the formal knowledge base of the more traditional firms and sectors. Not least the many small firms that operate as sub-contractors for Danish and foreign firms are at risk to lose their competitive position if they do not succeed to develop a stronger and more formalised knowledge base. Just hiring a single employee with academic training may for some of these firms be a first step toward upgrading and formalising their knowledge base. In sectors where almost all knowledge production has been out-sourced the vertical division of labour may need to be revised. This seems to be the case for contractors in the building business who are now stuck in a position in between architects and suppliers of materials with little room for innovation. Technological institutes and universities need to establish information services that give access for traditional firms to well established knowledge - a task that is quite different from linking front research to the needs of high technology firms.

Characterising the system in terms of human resource development

One reason why it is difficult to change the pattern of specialisation in the direction of science based and high technology products is that the Danish pattern of human resource development is connected to it in a systemic way. The Danish human resource development system (the school system, vocational training and the efforts made by firms to develop the skills of their employees) is quite unique. And, in certain respects, it matches quite well the Danish incremental approach to innovation in low and medium technology sectors. Therefore an upgrading and a stronger emphasis on formal (as contrasted to practical experience based knowledge) knowledge in the production system must involve changes in human resource development.

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

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

The Danish labour market gives weak incentives to firms for investing in training their personnel

The Danish labour market is characterised by high mobility between firms (as high or higher than in the US) but a more limited geographical mobility. Danish firms invest less in training their own personnel than firms in other countries. On the other hand, the public sector has built a unique and quite resource intensive system for training adults. This means that Danish workers on average get more time for training within a year than workers in other countries. Firms contribute through a wage tax to the finance of the public training and an important part of it is organised by tripartite bodies representing labour, industry and the public sector. This specific division of labour reflects among other things the fact that there are many small firms in the Danish economy that could not take on the responsibility for training their personnel on their own. But it has also resulted in bigger firms using less resources on internal training and developing explicit human resource development strategies to a lesser degree than their foreign counter-parts. DISKO data show that the more static, traditional firms more easily can get what they need from the public system than the more innovative firms and actually the more innovative firms do not use the public system very much – at least not directly.

The Danish labour market is flexible and efficient but it is also characterised by polarisation to the disadvantage of unskilled and foreign workers in terms of job opportunities

There are a number of unique features of the labour market that needs to be taken into account when considering the working of the over all innovation system. The substitutions rate of unemployment support is higher and support is less restricted in time than in other OECD-countries and this fact explains some of the peculiarities. It may explain the fact that workers in Denmark feel more secure in their jobs than their colleagues in other European countries with strong legal protection from firing and with much less mobility. High mobility reflects to a certain degree that employers meet almost no legal restrictions when it comes to firing personnel. But it also reflects that workers at all skill levels are less afraid of getting lost between different jobs when looking for new job opportunities. OECD and labour market economists have emphasised the negative impact on job incentives but an ‘irrational’ willingness to work seems in many cases to overcome this negative incentive. Among women, for instance, 20-30% work for a wage in spite of the fact that economically they could be almost as well off staying at home. The Danish labour market is performing well also in terms of low and falling rates of respectively structural, long term and youth unemployment.

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

What should be done about human resource development?

Again, in this area, we emphasise the need for change with a certain respect for continuity. To make a clean break with Danish traditions in the three problem areas

referred to cannot be done and, if it could, it would probably have a negative effect on the system as a whole.

We therefore propose that the cultural characteristics of the Danish basic education are retained while, at the same time, an attempt is made to strengthen the formal qualifications in reading, writing and mathematics. We also point to the fact that there is still a too big proportion of young people who only get a basic education and to reduce this group is necessary in order to weaken the tendency toward polarisation in labour markets. In both cases we propose an experimental approach and a more systematic analytical effort in education research strongly linked to practise. Referring to analytical results from the private sector, we warn against attempts to impose change from the outside by simplistic economic mechanisms. To give teachers strong incentives to experiment and to take active part in diffusing good practises is a key element in a change strategy.

There are obvious problems with the present division of labour between the firms and the public system for adult training and vocational training. Even so, we warn against just cutting down the public part of the system. There is no guarantee that the private firms will take over the responsibility and this would weaken the efforts to establish life-long learning and especially the low skilled workers would get even more exposed to social exclusion. Again, we point to the need for experimenting and generalising from experiments. The working of the Danish human resource development system (high inter-firm but low geographical mobility) tends to re-inforce the formation of 'industrial districts' (Medicon Valley around Copenhagen, MobileCom Valley around Aalborg etc.). This points to the potential for regional experiments trying out new constellations of collaboration between firms, schools and public authorities and new forms of co-ordination of respectively industrial policy, labour market policy and education policy at the regional level. We also propose the creation of a system for adult and vocational training where a part of the system should explicitly aim at serving firms that are engaged in on-going technical and organisational change.

Finally, there is a need to give special emphasis to the problems of integrating less skilled workers and foreign workers in the working life. The Danish mode of production and innovation is intense in terms of communication and it becomes increasingly so. Therefore, there is a need for giving foreigners a more efficient introduction to Danish culture and to the Danish language. Different general programmes giving employees access to leave for getting training should be made more selective and aim at the enhancing the skills of the least skilled workers.³ We point out that this 'new new deal' is not only a question of social justice. If nothing is done to upgrade the skills of the unskilled workers and of those with rigid skills, a growing proportion of the labour force will disappear from the labour market with bottle-neck problems as the result. It will also prove difficult to establish flexible and innovative organisations at the firm level since those typically involve a decentralisation of responsibility to all levels of the organisation. Finally, we raise the question if 'a learning economy' can flourish in a society where social cohesion is undermined. This last point should be seen on the background that the Danish economy, as other small economies, is strongly dependent on the production and reproduction of 'social capital' for its economic development.

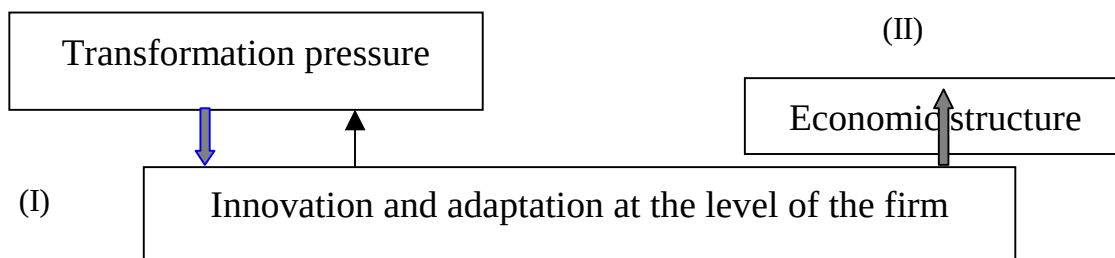
From structure to dynamics – transformation pressure, employment and innovation

So far the focus has been on the structure and basic functioning of the Danish innovation system. One way of testing the quality of a product or a technical system is to see how it reacts when it is put under external pressure. The same kind of test could be interesting to pursue when it comes to comparing the viability and dynamic capabilities of different national systems of innovation.⁴ For instance it would be quite interesting to analyse the different development paths of Denmark and Sweden over the last decade or so. Both systems have experienced a strong transformation pressure reflecting the combined impact of rapid technical change and globalisation but they have responded quite differently in terms of economic performance.

There has, for instance, been a remarkable change in the relative position of the two economies when income per capita levels are compared. In the middle of the 80s, GNP per capita was 20% higher in Sweden while, in the middle of 90s, there had been a change in the ordering and now GNP per capita is 20% higher in Denmark. Does the relative success of Denmark primarily reflect different strategies in terms of regulating the transformation pressure coming from globalisation (intelligent Danish macro economic policies or restrictions on devaluations imposed by the EMS) or is it rather structural and institutional characteristics (the innovation system) that explain these major differences in the transformation process?

In what follows we will illustrate the importance of mechanisms of transformation by data referring exclusively to the Danish economy. But the aim is to inspire comparative analysis in this area. Our starting point is a simple model where we link to each other the transformation pressure and the economic structure at the level of the whole economy, on the one hand, and, on the other hand, the adjustment and innovation processes at the level of the firm. The empirical analysis is incomplete since it refers exclusively to changes in existing firms and does not include the process of destruction and creation of firms. The basic model is shown in Diagram 1.

Diagram 1. The basic model – from macro to micro and back to macro



One of the most fundamental factors affecting the transformation pressure is *technical change*. New technology in the form of new products and new processes offers new opportunities as well as new threats for the single firm. A second major factor is the *competition regime*. New entrants into markets and extensions of markets bringing in new competitors located elsewhere are factors that increase the transformation pressure. *Governance regimes* – the role of ownership and finance in managing the firms – affect the intensity but also the direction of the transformation pressure. Finally the *macroeconomic stance* affects transformation pressure. For instance a

situation characterised by deflationary policies and an over-evaluated currency rate implies strong transformation pressure, as do aggressive trade union wage policies. Some of these factors affect all parts of the economy (the macro economic stance) while most of the others (technical change and the competition regime) are sector specific.

Different types of firm reactions to an increased transformation pressure

Firms may react to an increasing transformation pressure in a number of ways. They may go on as before without implementing any kind of change. They might try to reduce the 'fat' of the organisation. That might include strategies of 'quantitative flexibility' firing some of the personnel. Sometimes such a strategy will succeed and sometimes it will lead to a close down of the firm and its activities.

Another alternative is to adapt to the increasing pressure by moving resources from less promising to more promising activities. The capability to do so will reflect the degree of 'functional flexibility' of the firm. A related even more strategic form for behaviour is for the firm to engage in organisational change aiming at increasing the functional flexibility.

A third alternative is to introduce more efficient process technology and to introduce organisational change aiming at increasing the efficiency in the use of new technology.

A fourth alternative is to introduce product and service innovations that make it possible to side-step and reduce the intensity of competition in product markets.

A fifth alternative is to look for a new positioning within industrial networks. Establishing closer relationships to customers and suppliers and to knowledge organisations may affect the capability to cope with an increased transformation pressure in at least three different ways. First it may involve a simple sharing of risks, second it may enhance the functional flexibility of the firm and third it may make it possible to speed up innovation.

National systems differ in terms of to what degree they support these different, more or less reactive and pro-active, strategies at the level of the firm. Different sectors differ in terms of the opportunities they offer when it comes to pursue the different strategies. Technological opportunities differ between sectors and the same may be true for 'organisational opportunities' (see below).

Skills and transformation

Perhaps with the exception of the first of the above mentioned strategies, the increased transformation pressure, and the changes it provokes, will influence the skills demanded within the firm. A stronger emphasis on functional flexibility and innovative capacity will increase the demand for general personal skills having to do with co-operation and communication and it will also imply a stronger need for workers to take on an individual responsibility in the work process.

Technical change and product development will increase the demand for specific skills and for new types of skills. A speed up of the innovation process will increase

the rate of creative destruction of skills and competences. This will increase the need for life-long learning in the whole economy and at the level of the firm it will make it more necessary to move toward a 'learning organisation' format.

From firm strategies back to the whole labour market

When a group of firms adapts to the increased transformation pressure and adjust their demand for labour and skills accordingly, the aggregate demand for labour and specifically for different types of labour will change. Firms with different strategies for coping with the increased transformation pressure will also differ in terms of their hiring and firing strategies. This implies that changes in the over all labour market dynamics will reflect changes in the strategy of specific firms and in how such strategies are distributed in the population of firms. What happens in this respect in big and rapidly growing firms will, of course, have a greater impact than what happens in small and shrinking firms.

In what follows, we will introduce results from combining data from one of the surveys from DISKO with labour market statistics that illustrate some of the mechanisms discussed above. We will start by analysing how firms evaluate the relative weight of different factors affecting the transformation pressure. Second, we will demonstrate how the increased transformation pressure affects technical and organisational change. Third, we will show how the transformation pressure is reflected in the change in the demand for labour at the level of the firm and how the aggregate demand for labour can be regarded as the outcome of processes of transformation at the firm level. At the end, we will discuss some ideas about how the approach could be further developed.

The DISKO-data to be used

What follows is based on a unique combination of two data sets. The first is a Danish survey originally addressed to somewhat less than 4 000 Danish firms. We got close to 1900 useable responses from firms in manufacturing, transport, construction and service industries. Most of the answers were given by management. The response rate was 48%. Of the firms included 1200 had less than 50 employees and there are only a handful of responses from firms with more than 500 employees. The sample is stratified to include all the large firms and only approximately one fifth of small firms. The data in what follows are not weighted to adjust for this skewness and should therefore be interpreted to be valid for the specific group of firms in the sample rather than for all the Danish firms. The average size of the firm is about 80 employees. The firms were asked about their use of different forms of organisational forms, their investments in human resources and their activities in terms of technical innovations.⁵ *Most of the questions to be included in the analysis below referred to what changes had been experienced or initiated in the period 1993-95.*⁶

The second data set links statistical data on e.g. employment, training, creation and destruction of jobs, to the firms in the sample. When firms consist of more than one production unit we get a matching problem between the two data sets. This match has been done in such a way that the employment in the single biggest production unit within a firm has been connected to the questionnaire of its mother firm. In order to be included firms should exist both in november 1990 and 1994. After this, and after

excluding firms who ceased to exist, there are 1610 production units with a total employment of more than 140.000 in this data set.

In fact, a third data source is used to add information on the accounts and investments of the firms. This has been done by Statistics Denmark using their registers of official statistics, but in this case on a firm level.

The major problem with the data set is that, so far it only includes employment data for the period 1990-94. Only recently employment data for 1995, 1996 and 1997 has been released. When these data have been included in the data set it will be possible to pursue a more satisfactory illumination of the general ideas developed below. Even with this flaw, the combination of the three data sets produce interesting new insights. We use in this paper frequency analyses to show only part of the potentials in this data set. Here we only use a limited part of the data as the bulk of the paper is based on the DISKO-survey data, and in a few cases employment data. Further analyses are called for and will be pursued in the near future.

Transformation pressure as viewed from the firms

In the survey there was one question that gives an idea of how firms see the relative importance of different factors affecting the transformation pressure. Firms were asked what conditions had played a major role in changing the work content of employee.

Table 2: Proportion of firms responding 'high extent' to the following question: 'To which degree have the following conditions contributed to changes in work content of the employees during the period 1993-95?'

N=1869	All firms
1. Sharper Competition	30.2
2. Introduction of new technology	28.1
3. Need for better contacts with customers.	23.6
4. Better possibilities for development of new products or services	13.0
5. Need for better contacts with sub-contractors	9.7
6. Demands and wishes from the Employees	9.7

Table 2 shows that among the factors evoked in the questionnaire the one referred to most frequently is 'sharper competition'. The other factor given strong weight relates to the introduction of new technology. In what follows, we will use the response to a question about a change in the intensity of competition to illustrate how a change in the transformation pressure affects the behaviour of firms.

Intensified competition 1993-95

One way to make the transformation pressure variable operational is to take the experiences of firms as a starting point. Here we will use the firms' response to the question about if they had or had not experienced an increase in the intensity of competition for the period 1993-95.

Of all firms responding to this question (1869 firms) 40% report that the competition pressure had been strongly increased, 33% that it had increased somewhat while only

24% report no change or a milder competition pressure (3% respond that they do not know).

Table 3 shows that the increase in competition is not experienced evenly in the private sector. It is signalled most strongly by bigger firms and firms in some sectors are less prone to refer to it than firms in other sectors. Firms belonging to manufacturing and business services refer to much stronger competition more frequently, while firms in the construction sector do so less than the average.

Table 3: Share (%) of the firms that respond that they have experienced a 'much stronger competition in the period 1993-95' in different size categories and in different sectors.

	Manufacturing	Construction	Trade	Transport	Business services	The whole economy
Less than 50 employees	39.9 100	23.3 58	35.2 88	41.5 104	39.5 99	40.0
More than 50 employees	49.4 124	32.4 81	48.2 121	43.2 108	45.3 113	100

Source: Questions 20, 1, 26a and 26b in The Disko survey on organisation and qualifications at the firm level. See Lund & Gjerding for an account of the questions posed.

Table 3 illustrates that changes in the transformation pressure may be distributed unevenly in the economy. It is especially interesting that both the small and the bigger firms in the construction sector experience much less of an intensification in the transformation pressure than manufacturing firms that are more exposed to international competition.

Competition innovation, organisational change and network positioning

How does an increase in the transformation pressure affect product innovation, organisational change and the positioning in industrial networks? In the questionnaire, firms were asked if they had introduced new products or services, if they had gone through major organisational change and if they had established closer co-operation with customers and suppliers in the period 1993-95. In tabel 4 we present the share that respond yes according to how they have characterised the change in competition for the same period.

Table 4 illustrates that the firms experiencing much stronger competition were more frequently involved in product innovation and organisational change. The differences are even more significant when it comes to establish a closer collaboration with customers and suppliers. There is a strong connection between increased competition and closer vertical co-operation among firms.

These results may be interpreted in two different ways. Although there has been no explicit analysis of causality, the most obvious interpretation is that intensified competition 'is the cause of' or triggers change in the different dimensions (new

products, new forms of organisation and a change in network positioning). A complementary interpretation is that, in the period studied, competition has been intensified, especially, in those sectors where there (normally) is a lot of change going on in terms of technology and organisation. This second interpretation would, actually, indicate a tendency toward a polarisation of the economy. At the one pole we would find sectors characterised by accelerating change and intensified competition and at the other we would find sectors with slow constant change and with no increase in the competition pressure.

Table 4: Share of the firms that introduced changes in products, organisation and relationships with suppliers and users (%) among firms that experienced much stronger, somewhat stronger or unchanged competition 1993-95.

N=1869	MSComp-firms	SSComp-firms	UVComp-firms
Introduced a new product 1993-95 (%-share responding yes)	63.7%	55.7%	30.4%
Introduced a new form of organisation 1993-95 (%-share responding yes)	63.5%	54.3%	31.3%
Established a closer co-operation with customers 1993-95 (%-share responding yes)	54.1%	29.5%	20.4%
Established a closer co-operation with suppliers 1993-95 (%-share responding yes)	29.6%	15.6%	12.5%

Source: Questions 20, 1, 26a and 26b in The Disko survey on organisation and qualifications at the firm level.

One way to get a first idea about if the second mechanism may be at play is to compare the change in the competition pressure with the rate of organisational change sector-wise. In table 5 we present the share of firms in different size categories and sectors that have reported that they have introduced organisational change in the period.

Table 5: Share (%) of the firms that respond that they have introduced organisational change at least once in the period 1993-95 in different size categories and in different sectors.

	Manufacturing	Construction	Trade	Transport	Business services	The whole economy
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Less than 50 employees	52.0 99 (100)	28.5 54 (58)	43.1 82 (88)	28.3 54 (104)	52.3 100 (99)	52.3
More than 50 employees	75.2 144 (124)	52.9 101 (81)	64.9 124 (121)	64.4 123 (108)	66.7 128 (113)	100 (100)

Source: Questions 20, 1, 26a and 26b in The Disko survey on organisation and qualifications at the firm level.

Within parentheses we give the index number from table 3 so that we can see how far, in these broadly defined sectors, there is a match between the relative transformation pressure and the frequency of organisational change. We find a rather good match and that means that we cannot disregard the complementary hypothesis. Sectors characterised by frequent organisational change are normally also characterised by intensified competition.

But it is also important to note that the match is not perfect. The small transport firms experience an increased competition pressure at more than an average degree (index=104) but they introduce organisational change much less frequently than the whole population of firms (index=54). This may be taken as an illustration of the fact that 'organisational opportunities' may differ between sectors. 'Transport' includes restaurants and there might be limited possibilities for small firms in 'transport' – typically a small trucking firm or a grill bar to re-organise activities. It is interesting to note that this is not true for the bigger firms in this sector – here organisational change is stronger than expected, given the increase in the competition pressure (index=123 versus index=108). It is important to note that at this stage we only aim at illustrating some fundamental mechanisms of transformation and routes for exploring this issue further – it is not our errand to demonstrate statistically specific relationships.

In what direction do firms change their organisation?

Firms were asked if they had expanded the use of certain specific practices and organisational techniques. We shall compare firms reporting a much stronger competition with the rest of the firms concerning the direction of change.

Table 6: Proportion of firms responding 'yes' to the following question: 'Has the firm extended its use of the following organisational traits during the period 1993-95?'

	MSComp-firms	SSComp-firms	UVComp-firms	All firms
Delegation of responsibility	63.25% 111	58.36% 102	46.48% 81	57.23 (N=1653)
Cross occupational working groups	55.38% 106	55.75% 107	43.39% 83	52.19% (N=1029)
Quality circles/groups	51.78% 108	48.56% 101	42.51% 89	47.93% (N=845)

Integration of functions (e.g. sales production/service, finance)	51.98% 113	48.40% 105	31.97% 70	45.91% (N=1222)
Wages based upon quality and results (not piece time wage)	43.62% 102	45.99% 108	36.88% 86	42.69% (N=855)
Job rotation	46.84% 112	45.14% 107	27.40% 65	42.00% (N=781)
Systems for the collection of proposals from employees	48.38% 118	36.89% 90	34.07% 83	41.10% (N=978)

Source: Questions 8 a-g first part in The Disko survey on organisation and qualifications at the firm level. N refers to the total number of responses to the question. N varies because the questions are addressed only to the firms that have introduced the practice in question before or after the period referred to.

Table 6 shows (see the All firms-column) that increased delegation of responsibility is the form of change most frequently referred to but that many of the other, more advanced, forms of organisational change – such as introducing integration of functions – are also widely introduced and extended. The firms experiencing a strong increase in the intensity of competition have been more active in terms of organisational change in all the categories.

It is interesting to note that the difference between the MSComp-firms and the rest is most clear when it comes to ‘delegation of responsibility’, ‘integration of functions’ and ‘job rotation’. These are some of the core characteristics of the functionally flexible and innovative organisation. The analysis thus gives some support to the hypothesis that increased competition drives firms toward forms of organisation that are functionally flexible. The complementary hypothesis is more awkward here. It would be that an ‘exogenous’ wave of organisational change in certain sectors should give rise to an intensification in competition in those same sectors.

The transformation pressure and employment – from micro to macro

We have demonstrated that an increase in the transformation pressure, experienced as an increase in the intensity of competition at the firm level, seem to trigger changes in products and organisational forms. There is apparently a strong link between the increase in the transformation pressure at the macro level and the behaviour of the firms in these respects. Now we will turn to the opposite mechanism going from what happens at the level of the firm to the developments in the whole labour market.

The subset of firms included in the DISKO-survey covers the private business sector, excluding agriculture. These sectors employed 947.430 persons in 1993 (total employment in Denmark was close to 2.500.000). In total the private business sector included 57.461 workplaces with a total of 781.618 employed and belonging to firms that survived for the whole period 1990-94.

In terms of number of employees our realised sample is big in comparison to the total population. It can be shown that the employment in the sub-aggregate develops in parallel with the total employment in the business sector. At the same time it should be re-emphasised that the sample is not representative. It has an overweight of big firms as compared to the whole population of firms (in the DISKO-labour market production units on average employ more than 80 persons while the corresponding figure for the whole population is 15). Another problem, already referred to, with the

employment data is that they at the moment cover a rather short period and stop already in 1994. What follows should therefore be regarded as an explorative exercise and as a demonstration of analytical opportunities.

In table 7 we compare the employment development in three sub-aggregates of firms differentiated on the basis of how they have experienced the change in competition pressure.

Table 7: Employment 1990-94 in sub-aggregates of firms reflecting different experiences in terms of change in the intensity of competition.

	Nov. 90	Nov. 91	Nov. 92	Nov. 93	Nov. 94
Much Stronger (MSComp-firms)	73025=100	99.1	97.2	94.8	99.2
Somewhat Stronger (SSComp-firms)	46825=100	100.3	100.8	98.2	104.0
Unchanged or Weakened (UW-firms)	19140=100	105.6	101.3	99.9	105.3
Total	141.665=100	100.4	99.1	96.8	102.0

Table 7 shows that firms in the three groups differ regarding their employment development for the period 1990-94. It indicates that the subjective assessment of those responding to the questionnaire co-incide with real changes in the firm. Firms that refer to a much stronger competition reduce their staff with more than 5% between 1990 and 1993 while those referring to unchanged or weakened competition keep their employment at the same level. For the whole period 1990-94 there is some reduction in the employment in the firms referring to a much stronger competition while the number of employees is growing with around 5% in those with no increase in the intensity of innovation.

The pattern observed in table 7 indicates that firms, confronted with more intense competition, combine numerical flexibility with technical innovation and organisational change. Increasing the competition pressure on firms – for instance through effective revaluations of the currency will – at least in the short term – have a negative effect on employment.

Competition, product innovation and employment

We have just seen that the sub-aggregate of firms experiencing a much stronger competition had less employment growth 1990-94 than the rest. It is an interesting issue if the firms that engage in product innovation can compensate for the employment losses emanating from the increased competition pressure by entering new markets. In table 8 each of the sub-aggregates presented in table 7 have been divided into two – one including firms that have reported at least one important product innovation 1993-95 and one including firms that have not reported any product innovation.

Table 8 shows a mixed pattern in this respect. While aggregate employment in firms introducing new products is growing much more strongly in the firms experiencing a somewhat stronger competition this is not true for the other two categories of firms. But it is important to note that at the end of the period (1993-94) employment growth is stronger in firms introducing product innovations in all the three categories (5.0% versus 3.8% for MSC-firms, 6.8% versus 3.8% for SSC-firms and 6.9% versus 4.2% for the UWC-firms).

Table 8: Employment development 1990-94 for subaggregates characterised by differences in competition intensity and product innovation.

	Nov. 90	Nov. 91	Nov. 92	Nov. 93	Nov. 94
Much Stronger Competition (MSComp-firms) - Total	73025=100	99.1	97.2	94.8	99.2
Product innovative	55438=100	98.9	96.2	94.1	98.8
Non product innovative	17321=100	99.7	100.3	97.1	100.8
Somewhat Stronger Competition (SSComp-firms) - Total	46825=100	100.3	100.8	98.2	104.0
Product innovative	32066=100	100.1	102.5	100.6	107.4
Non product innovative	14150=100	100.6	97.8	94.2	97.8
Unchanged or Weakened Competition (UWComp-firms) - Total	19140=100	105.6	101.3	99.9	105.3
Product innovative	8043=100	111.1	99.8	95.7	102.3
Non product innovative	10955=100	101.8	102.5	103.1	107.4
Total	141.665=100	100.4	99.1	96.8	102.0

This is important because in the survey firms were asked about product innovations taking place in the period 1993-95 and there are good reasons to assume that the employment effect of product innovations will be realised only with some delay. Even so, the data might indicate that there are limits for how far product innovation can be used to ease the competition pressure when the intensity of competition grows very strongly. While a moderate increase in the transformation pressure may stimulate innovation and long term job creation a more drastic increase may have a negative impact.

A sector-wise break down of the data shows very different patterns in these respects in the different sectors. Construction industry, experiencing very little increase in the transformation pressure, is characterised by a perverse relationships where those firms which introduce new products have a much less positive employment growth and this is independently of the competition pressure. Actually this 'perverse' relationship is so strong that an exclusion of the construction data would give us the expected pattern where product innovation is positively related to employment in all the three categories.

Engineering and metal working industry is an important sector in the Danish economy both in terms of employment and exports. In table 9 we have reported the data in the same form as in table 8 but now for this specific sector.

Table 9: Employment development 1990-94 for subaggregates characterised by differences in competition intensity and product innovation in the engineering and metalworking industry.

	Nov. 90	Nov. 91	Nov. 92	Nov. 93	Nov. 94
Much Stronger Competition (MSComp-firms)					
Product innovative	23943=100	95.3	93.5	90.6	97.3
Non product innovative	4731=100	102.4	102.3	92.5	95.5
Somewhat Stronger Competition (SSComp-firms)					
Product innovative	13139=100	100.1	103.7	103.5	113.4
Non product innovative	4497=100	101.1	97.8	91.3	97.5
Unchanged or Weakened Competition (UWComp-firms)					
Product innovative	2498=100	113.6	107.8	97.1	107.0
Non product innovative	1749=100	101.4	108.3	108.6	119.2

In the two categories, where competition is intensified, firms that introduce new products increase their employment much more strongly than the average firm. This is true for the whole period but it is especially the case for 1993-94 (7.4% versus 3.2% for MSC-firms, 9.6% versus 6.8% for SSC-firms and 10.2% versus 9.8% for UWC-firms).

These results illustrate that there are differences between sectors in how a given firm response (product innovation) is related to performance. The very peculiar behaviour of construction industry has been recognised also in terms of productivity and quality problems and has now come into focus in the Danish industrial policy debate. At the same time we find that in important parts of the economy, product innovation is a way to reduce the negative impact on employment of increased competition intensity. The data indicate that the development of aggregate employment in the business sector will, *ceteris paribus*, be more positive if efforts to develop new products are intensified when there is a more intense competition.

We can thus conclude that increased competition on average implies a loss of employment that, in the short run, can only partially be compensated by the fact that it also triggers product innovations in the firms. We expect the employment data for 1995 and subsequent years to show that, as time goes by, the firms that have experienced a more intense competition and introduce new products will begin to create more jobs than those living a more calm life and not innovating. But the pattern observed indicates that there is a need to adjust the transformation pressure to the innovative capability of the whole economy and of the specific sectors. It cannot be

ruled out that the transformation may become too strong resulting in turning the process of creative destruction into more destruction than creation.

Changes in the content of work

We have now linked competition and product innovation to trends in aggregate employment. In this last part of the paper the focus will be on the skill dimension of the whole labour market. As pointed out, one weakness with the Danish labour market is that unskilled workers in terms of employment opportunities and unemployment are worse off than workers with more training. This is a general problem that has been growing in almost all OECD-countries in the period 1985-95 and the explanations given refer either to trade with low-wage countries or to technology as skill-biased (OECD 1994). In what follows we will see how far the phenomenon can be explained by a more intense competition. In table 2 we saw that firms, themselves, see this factor as the most important when it comes to explain changes in the skill requirements.

A series of questions in the survey refers to changes in the content of work and in the demand for skills. In what follows we will compare the firms reporting a much stronger competition pressure 1993-95 with the whole population in this respect. Table 10 shows how firms with different experiences in terms of a change in the intensity of competition report changes in work content.

Table 10: Proportion of firms responding 'more' to the following question: 'Has the content of work changed for the employees during the period 1993-95 with more emphasis on:'

Work cont.	MSComp-firms	SSComp-firms	UVComp-firms	All firms
1. Work autonomy	63.93 115	57.70 104	41.40 75	55.38 100
2. Co-operation with management	56.93 120	49.02 104	31.97 68	47.30 100
3. Occupational qualifications	52.76 113	49.51 106	34.92 75	46.71 100
4. Co-operation with colleagues	53.03 121	46.23 106	27.89 64	43.71 100
5. Contact to customers	49.39 121	41.97 102	29.02 71	40.98 100
6. Specialisation	32.71 108	29.84 99	27.89 92	30.18 100
7. Contact so sub-contractors	34.72 128	26.23 97	17.46 65	27.02 100
8. Contact to other firms	24.09 124	19.02 98	13.15 68	19.37 100
9. Routine content of work	6.33 92	6.07 89	9.30 136	6.85 100

Source: Question 20 in The Disko survey on organisation and qualifications at the firm level.

Table 10 shows that almost 50% of all firms report that there has been an increase in work tasks which are demanding in terms of work related ('occupational') qualifications. But even more important for the whole population of firms (see the All

firms-column) is the increase in the demand for general qualifications such as work autonomy and co-operation with management.

None of these are the factors that distinguish the MSComp-firms from the rest most clearly, however. MSComp-firms stand out as characterised by a strong *reduction* in routine work and specialised labour (figures not reported in the table). While they stand out in reporting that more and more of their tasks relate to communication inside and outside the firm (see the categories 2, 4, 5, 7 and 8 in the table).

Together this gives a picture of change in the work process where a more dynamic environment (intensification of competition) puts a premium workers that have the capability to absorb change and to interact with others in coping with change. In this context individual experts who are not prepared to adapt to new conditions and to communicate with peers who command different kinds of expertise will not be very useful. In the MSComp-firms the focus is on learning rather than on knowledge-intensity in specific fields.⁷

These data on the work content can be complemented with data on skill requirements. As can be seen from table 11, for the whole population, there is a strong increase in the demand especially for general competencies such as of responsibility, flexibility and capability to communicate. It also shows that the more strongly firms have experienced increased competition the more prone are they to point to a need for more qualifications in all these respects. The intensity in the increase of the demand for the MSComp-firms is especially strong in relation to flexibility and communicative abilities. This pattern of response gives further support to the hypothesis that intensified competition is a major force behind the shift in the demand for labour toward a workforce which can adapt to a rapidly changing environment by being responsible, able to communicate and co-operate.⁸

Table 11: Proportion of firms responding 'larger' to the following question: 'Has the firm changed the demands when recruiting employees during the period 1993-95 Regarding:'

N=1869	MSComp-firms	SSComp-firms	UWComp-firms	All firms
Responsibility and quality consciousness	72.14 117	65.57 106	42.40 69	61.80 100
Ability to readjustment	63.66 122	54.59 105	32.43 62	52.06 100
Ability of co-operation and communication	62.05 121	54.43 106	31.75 62	51.15 100
Vocational qualifications	56.39 123	45.74 99	31.07 68	46.01 100

Source: Questions 13 a-d in The Disko survey on organisation and qualifications at the firm level.

So far we have demonstrated how the intensified transformation pressure goes hand in hand with organisational and technical change. Firms respond to the increased

pressure by introducing product innovations and by introducing new forms of organisation within the firm and with external parties that increase their functional flexibility. The complementary hypothesis is that sectors where firms are active in terms of technical and organisational change are the sectors that get exposed to a stronger transformation pressure.

We have also shown that firms experiencing a stronger transformation pressure are the ones that change their requirements for skills most strongly. They distinguish themselves from the others, especially, when it comes to reduce routine labour and the degree of specialisation and when it comes to require more general personal skills related to co-operation, communication and taking responsibility. Now we will turn to an explorative analysis of labour market statistics – the same limitations of the data as pointed out in earlier sections should be taken into account for what follows.

Competition and the relative employment opportunities for unskilled workers

In this section we explore: How does the employment pattern for the unskilled workers develop as compared that of all workers? Specifically, we will analyse how it develops in the three sub-aggregates related to the change in the intensity of competition. We assume that unskilled workers have a more limited capability to learn because they have not ‘learnt to learn’ in the formal education system, we should expect them to experience a relative weakening of their position especially in firms experiencing a much stronger competition. As we shall see below, this tendency is quite weak and it indicates that such a hypothesis may be too simplistic in identifying the capability to learn to the formal training of the worker.

Table 12: Employment 1990-94 in subaggregates of firms reflecting different experiences in terms of change in the intensity of competition.

		Nov. 90	Nov. 91	Nov. 92	Nov. 93	Nov. 94
Much stronger competition	All	73025=100	99.1	97.2	94.8	99.2
	Unskilled	31685=100	97.1	92.0	87.7	91.8
Somewhat stronger	All	46.825=100	100.3	100.8	98.2	104.0
	Unskilled	19.540=100	97.8	96.8	90.8	96.7
Unchanged weakened	All	19.140=100	105.6	101.3	99.9	105.3
	Unskilled	8.705=100	104.9	96.6	93.4	99.7
All ⁹	All	141.665=100	100.4	99.1	96.8	102.0
	Unskilled	61.094=100	98.5	94.4	89.7	94.9

Table 12 reflects a pattern where the proportion of unskilled workers in the whole sample is reduced quite strongly within the 4-year period covered (from 43.1% to 40.1%). Of the total net job loss for unskilled workers 1990-94 (3285 jobs), 80% (2613) were lost among firms experiencing a much stronger competition and 20% (650) was lost among firms experiencing somewhat stronger competition. The number of unskilled jobs remained practically unchanged among firms experiencing unchanged or weaker competition.

The *relative* position of the unskilled workers is weakened in all the three categories for the period 1990-94. There is, however, only a slight tendency that the relative position of the unskilled workers is weakened most strongly in the parts of the economy where competition has been intensified most strongly (the proportions go from respectively 43.4% to 40.2% for MSC, 41.7% to 38.8% SSC and 45.1 to 43.1 UWC).

Given that the questions on the change in the competition pressure referred to the period 1993-95 it is of special interest to see what happens in the last period for which we have employment data, 1993-94. In this year, characterised by strong employment growth (more than 5%), the relative position of the unskilled workers does not deteriorate further in any of the sub aggregates: the growth of the number of unskilled workers follows closely the general trend independently of the competition pressure. This is a point where the short time frame makes the results less reliable. Cyclical patterns may dominate and hide the long run trend.

On the one hand, the employment data show that most of the job losses for unskilled workers take place in firms experiencing a much stronger competition. On the other hand, they give only weak support to the hypothesis that a more intense competition contributes directly to the relative weakening of the position of the unskilled workers.

The fact that the relationship between competition and a weakening of the relative position of the unskilled workers, in the register data, is less strong than the link between competition pressure and shift in demand for skills, as registered in the survey, is interesting. It may be taken as an indication of the fact that, at least in Denmark, these workers are far from 'unskilled' in an absolute sense and that formal training is not all that matters in the learning economy.¹⁰ In case studies we found a number of instances where unskilled workers have been more easy to integrate in connection with the introduction of new forms of organisation than skilled workers. But the same case studies also demonstrate that a lack of general skills, in terms of capability to read, write and calculate, may be barriers to change toward forms characterised by functional flexibility and delegation of responsibility to operators (Voksted, 1999). Strengthening such general skills among 'unskilled' workers through a system for adult training may be an important element in reducing the tendency toward polarisation in the economy.

We have made an attempt to explain one of the most important macro trends in the labour market – the relative weakening of the position of unskilled labour – by aggregating the reactions of firms on an intensification of competition. The short time span of the employment data undermines the reliability and validity of the effort. So far, we can show that the net reduction of unskilled workers took place exclusively in firms exposed to an intensification of competition. But we cannot show that the

relative position of the unskilled workers was weakened more strongly in firms exposed to a much stronger transformation pressure than in the rest of the firms.

Concluding remarks

The general purpose of this paper has been to demonstrate the fruitfulness of a broader approach to national innovation systems that takes its starting point in the national production and human resource development systems. In the first part of the paper we tried to indicate by illustrations from the Danish economy that it might be difficult to change important characteristics in the innovation and production system without radical reform of the human resource development system. The two dimensions are closely connected and it is difficult to understand the dynamics in one of the dimensions without taking into account what goes on in the other.

In the second part of the paper we made an attempt to illustrate new analytical and political perspectives that might be evoked by this broader approach. It was shown that the general economic climate in terms of the transformation pressure and the intensity of competition has a major impact on what firms do in terms of technical innovation and organisational change. The other way around we demonstrated that it is possible to gain new insights regarding the macro-dynamics by starting from what is taking place in the firm. We illustrated this with an analysis of how the behaviour of firms affect aggregate employment and the employment of unskilled workers but a similar exercise could have been pursued regarding economic growth and productivity. An important missing link in this part of the analysis that should be integrated in future studies is, of course, a study of the creation and destruction of firms.

One policy implication of the analysis is that a sharp sectoral division of responsibility between macro-economic and competition policy on the one hand and education, labour market and innovation policy on the other hand is problematic. More generally, we would argue, both at the analytical and the policy level, extreme specialisation and the absence of common more holistic view of what is going on give rise to myopic perspectives and sub-optimising actions.

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Appendix A: List of papers in English:

Lundvall, Bengt-Åke & Nielsen, Peter: Competition, transformation and polarisation in the learning economy – illustrated by the Danish case, forthcoming in *Revue Economique d'Industrielle*.

DRUID Working Papers:

Lund, Reinhard Organizational and innovative flexibility mechanisms and their impact upon organizational effectiveness, 1999

(ISBN87-7873-061-9)

Joergensen, Kenneth Moelbjerg .: Information Technology and Change in Danish Organizations, 1998

(ISBN87-7873-044-9),

Lundvall, Bengt-Åke & Kristensen, Frank Skov.: Organisational change, innovation and human resource Development as a response to increased competition, 1998

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Kristensen, Frank Skov: The Performance of Different Organisations under Different Market Conditions: An Empirical Analysis of the Organisational Structure and Performance of 1900 Danish Firms., 1997

Lund, Reinhard & Gjerding, Allan Næs: The flexible company Innovation, work organisation and human resource management, 1996

(ISBN 87-7873-017-1)

Gjerding, Allan Næs: Organisational innovation in the Danish private business sector, 1996

(ISBN 87-7873-06-3)

Appendix B: Members of the DISKO-project

The research project is headed by professor Bengt-Åke Lundvall.

Other participants are:

Professor Carsten Stig Poulsen,

Professor Emeritus Reinhard Lund,

Docent Preben Sander Kristensen,

Associate professors Peter Nielsen, Birgitte Gregersen, Erling Jensen

Assistant professors Poul Thøis Madsen, Allan Næs Gjerding and Jesper Lindgaard Christensen

Research assistants Martin Jørgensen, Anna Patrizia Rogaczewska, Anker Lund

Vinding, Bolette Abrahamsen, Lone Nielsen, Birgitte Hansen and Søren Voxsted.

Ph.D.-students Kenneth Jørgensen, Frank Skov Kristensen, Søren Nymark and Ina Drejer.

In addition a number of students have assisted the researchers.

The secretary of the project is Dorte Køster assisted by Pernille Wittrup Pedersen.

Appendix C: DISKO-reports (in Danish)

Rapport nr.1: Allan Næs Gjerding (med bidrag fra Kenneth Jørgensen, Frank Skov Kristensen, Reinhard Lund, Bengt-Åke Lundvall, Poul Thøis Madsen, Peter Nielsen og Søren Nymark). Den fleksible virksomhed: Omstillingspres og fornyelse i dansk erhvervsliv, Erhvervsudviklingsrådet, København, september 1997.

Rapport nr. 2: Kenneth Jørgensen, Frank Skov Kristensen, Reinhard Lund og Søren Nymark. Organisatorisk fornyelse - erfaringer fra 24 danske virksomheder, Erhvervsudviklingsrådet, København, marts 1998.

Rapport nr. 3: Søren Voxted (med indledning ved Bengt-Åke Lundvall). Efteruddannelsessystemets rolle og muligheder i det danske innovationssystem, Erhvervsudviklingsrådet, København, marts 1998.

Rapport nr. 4: Ina Drejer (med indledning ved Bengt-Åke Lundvall). Den vidensbaserede økonomi, Erhvervsudviklingsrådet, København, maj 1998.

Rapport nr. 5: Jesper Lindgaard Christensen (red.), Lars Dyhrberg, Peter Livoni og Jens Rygaard. Private investorers bidrag til innovation, Erhvervsudviklingsrådet, København, september 1998.

Rapport nr. 6: Poul Thøis Madsen. Den samarbejdende virksomhed, Erhvervsudviklingsrådet, København, januar 1999.

Rapport nr. 7: Peter Nielsen. Personale og fornyelse, Erhvervsudviklingsrådet, København, august 1999.

Rapport nr. 8: Jesper Lindgaard Christensen, Birgitte Gregersen og Anna Patrizia Rogaschewska. Vidensinstitutioner og innovation, Erhvervsudviklingsrådet, København, august 1999.

Rapport nr. 9: Bengt-Åke Lundvall. Det danske innovationssystem – et forskningsbaseret debatoplæg om innovationspolitiske udfordringer og handlemuligheder, Erhvervsudviklingsrådet, København, sept 1999.

Voxted, Søren; Kan kurser ændre holdninger?, Erhvervsfremme Styrelsen, København, marts 1999.

Danish **R**esearch **U**nit for **I**ndustrial **D**ynamics

The Research Programme

The DRUID-research programme is organised in 3 different research themes:

- *The firm as a learning organisation*
- *Competence building and inter-firm dynamics*
- *The learning economy and the competitiveness of systems of innovation*

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the resource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human resources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

The Ph.D.-programme

There are at present more than 10 Ph.D.-students working in close connection to the DRUID research programme. DRUID organises regularly specific Ph.D.-activities such as workshops, seminars and courses, often in a co-operation with other Danish or international institutes. Also important is the role of DRUID as an environment which stimulates the Ph.D.-students to become creative and effective. This involves several elements:

- access to the international network in the form of visiting fellows and visits at the sister institutions
- participation in research projects
- access to supervision of theses
- access to databases

Each year DRUID welcomes a limited number of foreign Ph.D.-students who want to work on subjects and projects close to the core of the DRUID-research programme.

External projects

DRUID-members are involved in projects with external support. One major project which covers several of the elements of the research programme is DISKO; a comparative analysis of the Danish Innovation System; and there are several projects involving international co-operation within EU's 4th Framework Programme. DRUID is open to host other projects as far as they fall within its research profile. Special attention is given to the communication of research results from such projects to a wide set of social actors and policy makers.

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NOTES

¹ Today, we would add that it is also interesting to combine the two perspectives. In the DISKO-project we have seen new possibilities to link to each other the analysis of industrial networking and the distribution of skilled people - for instance showing how firms with academically trained personnel communicate more easily with universities than other firms. This indicates that a systematic linking of career paths to networking patterns could be a fruitful endeavour.

² There is one more area where we recommend more socio-economic research. We argue that there is a strong need for research that aims at understanding the socio-economics of creating, disseminating and using knowledge.

³ We argue that older unskilled workers should retain the opportunity to leave the labour market at an age lower than the standard retirement age.

⁴ A more evolutionary metaphor would be to refer to the comparison of how different biological systems experiencing the same kind of climatic change adapt and evolve.

⁵ The definition of technical innovation follows the Oslo-manual standard. However, firms were also asked about their introduction of new information and communication technologies and their possible organisational innovations.

⁶ For a detailed presentation of the data set see Gjerding (1996) and Lund&Gjerding (1996).

⁷ This may be one reason why the weakening of the relative position of the unskilled workers is only marginally affected by the change in the pressure of competition (see the comments to table 12 below).

⁸ The fact that the shift in the demand for labour is not mainly for more skilled people but rather for workers with a high learning capability is emphasised in the recent OECD analysis of Technology, productivity and job creation, where it is stated that '...technical change is less biased against certain types of skills than against the inability to learn.' (OECD 1996, p. 9).

⁹ Includes a small number (2.625) of jobs located in firms that answered 'do not know' on the question about the change in the competition regime.

¹⁰ See, for instance, footnote 7.