*Good*NIP

Good Practices in Nordic Innovation Policies

Part 2

Innovation Policy Trends and Rationalities

A report produced by STEP, Verket för näringslivsutveckling (NUTEK), VTT Technology Studies, Danmarks Tekniske Universitet, and Rannsóknarráð Íslands (RANNIS)

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STEP - Centre for Innovation Research

Address/Location:
Hammersborg torg 3,
NO-0179 Oslo, Norway

Phone: +47 22 86 80 10
Fax: +47 22 86 80 49

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Part 2: Innovation Policy Trends and Rationalities

AUTHOR(S)

Per Koch and Juha Oksanen (eds.)

CLIENT(S)

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ABSTRACT

The main objective of Good Practices in Nordic Innovation Policies has been to develop a survey and an analysis of Nordic innovation policy instruments that directly or indirectly are targeting small and medium sized enterprises. The project is to provide Nordic policy makers with information to be used in the development of new or adjusted policy instruments on a national or Nordic level. The project unites researchers from the five Nordic countries: Norway, Iceland, Finland, Denmark, and Sweden. The study is coordinated by Norwegian STEP, a part of SINTEF Industrial Management. The other participants are NUTEK and VINNOVA of Sweden, VTT of Finland, Denmark's Technological University and the Icelandic research council RANNIS.

Innovation policy trends and rationalities The main chapter of this report gives a thorough presentation a comparison of contemporary innovation policies and policy instruments in the Nordic countries, historically and contemporary. The chapter ends up with several policy recommendations. A separate chapter discusses how policy development actually takes place in ministries and agencies, and introduces the concept of rationalities – i.e. common mental maps or frameworks of understanding that underpins policy development. This chapter also examine policy learning practices in the Nordic countries and gives some concrete advice on how to improve such learning processes. The report then goes on to a presentation of relevant innovation policy statistics and indicators. This is more than a listing of numbers and tables, however. The chapter uses these figures in order to gain a better understanding of the current status of innovation and R&D in the Nordic countries, and tries to analyse to what extent there is a connection between this status and current innovation policies. The final chapter contains more general theoretical reflections on innovation theory and innovation policy development. It discusses the interaction between innovation research and innovation policy as well as various rationales for innovation policy development. In an appendix the reader will find national rapports on the historical background for innovation policies in the Nordic countries.

KEYWORDS	ENGLISH	NORWEGIAN
GROUP 1	Industrial Management	Teknologiledelse
GROUP 2	Innovation	Innovasjon
SELECTED BY AUTHOR		

A reader’s guide to GoodNIP

The Nordic Industrial Fund SME Forum has funded the trans-Nordic research project on good practices in Nordic innovation policies (GoodNIP). The Nordic Industrial Fund – Center for Innovation and Commercial Development is an institution under the Nordic Council of Ministers. Its aim is to strengthen the Nordic business sector through the creation of a Nordic knowledge market, and the organisation does this by initiating and financing projects and activities that create synergy between actors in the Nordic innovation system.

The main objective of *Good Practices in Nordic Innovation Policies* has been to develop a survey and an analysis of Nordic innovation policy instruments that directly or indirectly are targeting small and medium sized enterprises. The project is to provide Nordic policy makers with information to be used in the development of new or adjusted policy instruments on a national or Nordic level. The project unites researchers from the five Nordic countries: Norway, Iceland, Finland, Denmark, and Sweden. The study is coordinated by Norwegian STEP, a part of SINTEF Industrial Management. The other participants are NUTEK and VINNOVA of Sweden, VTT of Finland, Denmark's Technological University and the Icelandic research council RANNIS.

Many of the researchers are also involved in the EU Trend Chart on innovation a European effort providing policy makers and managers of innovation support schemes with summarised information and statistics on innovation policies, performances and trends.[1] The objective for GoodNIP has not been to duplicate Trend Chart efforts, but to use Trend Chart data and reports as a foundation for further in depths studies. The GoodNIP study may hopefully be considered a contribution to the work done by the EU Commission, the OECD and the Nordic Council.

The GoodNIP deliveries consist of three reports:

Report 1: Summary and policy recommendations

Report one contains a summary of the GoodNIP exercise, presentations of modern innovation theory and innovation policy developments in the Nordic countries, as well as various policy recommendations.

Report 2: Innovation policy trends and rationalities

The main chapter of Report 2 gives a thorough presentation a comparison of contemporary innovation policies and policy instruments in the Nordic countries, historically and contemporary. The chapter ends up with several policy recommendations. A separate chapter discusses how policy development actually takes place in ministries and agencies, and introduces the concept of rationalities – i.e. common mental maps or frameworks of understanding that underpins policy development. This chapter also examine policy learning practices in the Nordic countries and gives some concrete advice on how to improve such learning processes.

The report then goes on to a presentation of relevant innovation policy statistics and indicators. This is more than a listing of numbers and tables, however. The chapter uses these figures in order to gain a better understanding of the current status of

[1] http://www.trendchart.org

innovation and R&D in the Nordic countries, and tries to analyse to what extent there is a connection between this status and current innovation policies. The final chapter of Report 2 contains more general theoretical reflections on innovation theory and innovation policy development. It discusses the interaction between innovation research and innovation policy as well as various rationales for innovation policy development.

In an appendix the reader will find national rapports on the historical background for innovation policies in the Nordic countries.

Report 3: Innovation policy measures, documents and government structures
Report 3 is essentially a reference book for innovation policies in the Nordic countries, and includes:

- Presentations of the innovation policy governance structures of the Nordic countries
- Summaries of relevant policy documents
- "Datasheets" presenting selected innovation policy measures
- An extended list of policy measures that goes beyond the ones included in the datasheet section

For more information on GoodNIP, see the GoodNIP Web site at http://www.step.no/goodnip

Researchers
The following persons have been involved:

STEP, Centre of Innovation Research, a part of SINTEF Industrial Management, Norway
- Per M. Koch (Project Leader)
- Johan Hauknes
- Marianne Broch
- Siri Aanstad
- Rannveig Røste
- Nils Henrik Solum

Verket för näringslivsutveckling (NUTEK), Sweden
- Staffan Larsson (Team Leader)
- Lennart Norgren (VINNOVA)
- Jennie Granat (VINNOVA)

VTT Technology Studies, Finland
- Juha Oksanen (Team Leader)

Danmarks Tekniske Universitet, Denmark, Institut for Produktion og Ledelse (IPL)
- Jørgen Lindgaard Pedersen (Team Leader)
- Søren Jensen
- Kasper Edwards

Rannsóknarráð Íslands (RANNIS), Iceland
- Thorvald Finnbjörnsson (Team Leader)

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1. Innovation Policy Trends in the Nordic Countries

Introduction

In this chapter we are analysing differences and similarities between the innovation policies in the Nordic countries. Focus is on innovation structures, R&D and innovation policy priorities and policy designs targeting directly or indirectly small and medium sized enterprises. There are also examples of "good practice" that may serve as an inspiration for the development of national and Nordic policy measures. Overall, the report at hand together with the two other reports produced by the GoodNIP research team aims to provide reader with information on trends of innovation policies in comparable context of small and open economies of the Nordic countries.

The first subchapter will shortly present some general remarks concerning Nordic countries. In this connection will be also touched upon a number of significant changes, which have taken place during the last 10 years in Nordic countries.

In the second part of this chapter structures and co-ordination of national innovation systems at the higher policy level will be examined.

The third part summarises main trends in national innovation policy priorities during the recent past.

In subchapter 4 attention will be paid on major components of national innovation policies. Topics studied in this chapter include innovation financing; promotion of networking; commercialisation of research; entrepreneurs and SMEs role; and integration of innovation and regional policies.

In subchapter 5 a overview on the innovation policy measures are presented with two complementary categorisations.

Main conclusions will be discussed in the chapter 6, whereas the final chapter will address the main policy recommendations drawn in the GoodNIP project.

Key trends in the Nordic countries since 1990

The Nordic countries — Denmark, Finland, Iceland, Norway and Sweden — form an unique group for policy studies, because of number of common societal characteristics, development trends and closely intertwining histories. At the same time there are wide variation in the industrial structures between the Nordic countries, which are explained among others by differing natural resources, development trajectories and past policy decisions.

Large export oriented firms have played historically important role in Finland and Sweden. Some of the companies from forestry, engineering and – lately -- information and communication technology sectors are nowadays multinational corporations with sites and activities around globe, but with headquarters in the countries of origin. This small number of large companies give a distinct flavour for R&D spending in Finland

and Sweden, because these companies stand for an important share of total research and development expenditures.

Denmark, Iceland and Norway each has an economy which is characterised by small and medium sized companies (SMEs). Otherwise industrial structures of the three countries differ. Beside a few large globally operating companies mainly in engineering, food processing and logistics Denmark has been successful in nurturing a vivid SME sector, which covers firms from more traditional as well as newer industries. Research and development expenditures are in par with the OECD average despite the industrial structure and R&D is currently defined to be a key future area in government strategies.

Because of its natural resources Norway's economy is dominated to large degree of the oil and gas industries. Norway has in general an industrial structure which is focused in sectors which are not especially research and development intensive. However, the government has set as a long-standing goal that research and development investments should be increased substantially.

During the last decade all the Nordic countries have vigorously searched for policies supporting renewal new paths in order to modernise their economies. Reasons for this quest for novel priorities are partly common to all the countries, but also partly country specific. We can mention the end of the Cold-War political divide, European integration and the development of the European Union, the economic recession at the beginning of the 1990s, increasing economic interdependence at global level and emergence of fast growing new industries such as information and communication technologies and biotechnology.

Depending on various factors, such as a country's geopolitical position, national industrial and financial structure, direction of international trade flows etc. the Nordic countries have been affected by these global changes to a larger or lesser degree.

Historically the state has played an important role in development of economy in the Nordic countries. Until the end of the 1980s active regulation of macro-economic factors and macro-economic environment was a dominant mode of economic policy making in countries like Finland, Iceland, Norway and Sweden. Governments, together with the national banks, actively regulated macroeconomic environment through monetary policies. Governments did not hesitate to support international competitiveness of major domestic industries through devaluation of national currency. High inflation was a consequence of this monetary policy.

During the 1980s focus of government policies started however gradually change. This process has in all the Nordic countries led to a deregulation of financial markets, abolishment a number of protectionist measures concerning domestic markets and renewed monetary policy objectives. Monetary policies have been geared towards stable value of currency and the maintenance of price stability, i.e. low inflation. The strengthening of competition policy and privatisation of public companies took place side by side with an emphasis on price and exchange rate stability.

The reasons for these changed economy policy objectives are to be found in international economic trends. The European integration process towards a single market has caused further pressure towards adjusting national economy policies to changes in a broader environment. It should be remembered that although Denmark was the only Nordic country which was member of the European Union (EU) in the beginning of the 1990s, the other Nordic countries were included in the single market process through the European Economic Area (EEA) Agreement between the EU and countries belonging to the European Free Trade Area (EFTA). The EEA Agreement was signed in May 1992 and came into effect at the beginning of 1994. Finland and Sweden became full members of the EU at the beginning of 1995. However, the EEA Agreement still covers Iceland and Norway.

At the beginning of 2002 Finland, together with 11 other EU member countries, joined the Euro-zone, which meant the replacement of separate national currencies by the European Single Currency. This move is important, as deflation of the national currency is no longer an available policy tool for the Finnish government.

The macro-economic environment of the Nordic countries is not the only area which has gone through drastic changes. During the last 10 years the countries' industrial structures have diversified and at the same time the business orientation of companies has changed quite considerably in countries, especially in like Iceland and Finland. Nordic enterprises have been fast to capitalise on emergence of new growth areas, such as information technology, telecommunication and the biotechnology sector.

There are no simple explanations for success of Nordic based companies in the emerging markets. The development since the mid-1990s has been well in line with the strategy of re-industrialisation adopted in the Nordic countries in the 1980s. The new strategy was based on the idea that future industrial expansion was dependent on success within a few core high-tech technologies. It was a widely shared opinion that economic growth could not be achieved by incremental improvement of old products only, or by increasing the efficiency of old mature industries. There was also a need for developing new products or even completely new industries. The success of Finnish and Swedish information and telecommunication industries in the last years of the 1990s were interpreted by many as a clear evidence of the “creative destruction” of industries and the birth of new ones. This stance was strengthened by mounting difficulties faced by traditional industries, as they struggled to maintain their competitive position in the middle of increasing international competition. This two coinciding trends seemed to proove that we are witnessing a process of structural replacement of old industries – often denoted as sunset industries – with new sunrise industries. For a moment, the road to the future seemed paved for “knowledge intensive industries”.[2]

However, it is important to remember that the picture on industrial development of the Nordic countries is not that black and white. For example, Denmark has succeeded in maintain a competitive position in several industries which are usually seen as traditional and not R&D intensive and which, in addition, are dominated by small and medium sized companies. The Danish design, furniture and clothing industries are examples of successful adaptation to a changing market. Moreover, Norwegian and Icelandic fisheries and other industries based on raw materials can document growth

[2] In political rhetoric ”knowledge intensive” is often understood as modern R&D intensive ”high tech” companies. It should be empasised that also ”low tech” companies make use of advanced technologies. Moreover, all human societies in the past and present are knowledge based.

and profitability during the recent past. Even in Finland and Sweden traditional strongholds like the forest and engineering industries have not lost their foothold in the national economies.

A distinct trend taken place during the last decade or so concerns the changing market orientation of businesses in geographical terms. In the past only a small proportion of industries were genuinely oriented towards international market, whereas many industries were focusing on domestic market. Today the number of Nordic companies targeting global markets has risen evidently.

A related trend is the broadening of the definition of “home market” from covering the national level to larger regional entities, like the whole Northern Europe. Industrial firms, financial institutions and other service providers, alongside retail trade companies, are increasingly seeing Northern Europe as their home market. Also inter-company mergers between the Nordic countries have intensified notably during the last ten years, including among others telecom companies, energy suppliers, forest industries, banking and IT services.

All these changes put extra pressure on Nordic politicians and policy makers designing policies for the future welfare of society. It is not surprising that governments have started to look for policy mixes which can fit new policy rationalities. In this context the systemic approach of the national innovation systems thinking has attained a lot of attention. It is increasingly understood that sustainable competitiveness of industries cannot be enhanced through narrowly defined sector policies. Instead what is needed is more broad based policy approach covering not only traditional areas of research and technology development or industrial policies but also education, regional development, renewal of traditional “low-tech” industries etc.

In Finland a quest for wider perspective was brought forth in policy discussion by the national Science and Technology Policy Council, which voiced need for “social innovations” — still vaguely defined — in its triennial review on science and technology policy, published in 2002. The same need is expressed in the Swedish debate on the Swedish paradox of having slow long-term economic growth and simultaneously a very high R&D-spending, primarily by industry. As a consequence the efficiency of the national system in terms of producing innovations and economic growth has been questioned. In these two examples it is not probably question of disillusionment with R&D per se, but rather realistic stance towards conditions and policies needed to ensure future welfare.

In the following chapters we will review more thoroughly how and through which kind of measures the challenges are tackled in the Nordic countries.

Structures and co-ordination of national innovation systems

Institutional characteristics of innovation policy structures[3]

Higher level structures for innovation policy making differ modestly in the Nordic countries. At the ministry level it is usually ministries responsible for trade and industry and for education and research which the play major role in the policy fields most closely related to innovation policy making in narrow sense. Traditionally also various other ministries are included in decisions concerning research and technology development, for example through appropriations for sector specific research and sector research institutes. Furthermore, the Ministry of Finance has a significant role in innovation policy making. Through its responsibility for the overall governmental budget allocation the Ministry of Finance has an important influence on the framework conditions of the innovation system.

However, currently several Nordic countries are considering a possible reorganisation of the institutional layout and policy making structures in order to reflect a more systemic approach to innovation policy. Traditional administrative boundaries between sectors dealing with research financing, industry oriented R&D or innovation funding or more general business development needs are seen increasingly as problematic and unsuitable for more comprehensive approach to innovation policy. The issue will be dealt with more thoroughly in the next chapter.

In every Nordic country there are a layer of important intermediate organisations, including research councils and other agencies, which main responsibility is to provide advisory services and allocate public research and innovation financing to universities, research institutes, and enterprises and to other research performers. Internationally there is substantial variation between countries as regards the authority of these intermediate agencies in relation to policy design and decision-making power on funding.

In the Nordic context the most unique example is probably offered by the Swedish system, because there is a number of significant research funding organisations outside the control of the state. Apart from large private foundations there are research foundations established by the centre-right government in the early 1990s. The government created new financing institutions by liquidating the so-called wage earners funds and transferring the capital to a number of new research foundations. The statutes concerning the research foundations restrict the government's possibility to steer the foundations considerably. In practise this means that the influence of policy on the direction of research has decreased, because large-scale and multidisciplinary research investments in strategic technology fields are managed outside the policy domain.

The third tier of the national innovation policy systems covers organisations and other actors that perform research and innovation. At this level the countries institutional arrangements differ greatly. Swedish public R&D system is heavily geared towards

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[3] In addition tothe material produded by the GoodNIP researchers also of Patries Boekholt & Erik Arnold et al (2002) The Governance of Research and Innovation — An international comparative study, Synthesis Report is used as a source in this chapter.

universities, whereas the public research institute sector is quite small in international comparisons. According to a long-standing principle publicly funded research should, as far as possible, be carried out in universities and not in research institutes. Therefore, the production of new knowledge, technology and innovations has centred in universities and enterprises.

Contrary to Sweden government research institutes play an important role in the national innovation system in Norway and Denmark. In Denmark there are almost 30 Government Research Institutions, which are established by the various Ministries. The primary task of these institutions is research and the provision of advice. The research institutions are presently regulated by the Act on National Government Research Institutions. An examination of role of the institutions in the future research and innovation system of Denmark is under preparation, and new Bill is to be prepared for Parliamentary hearing in 2003. In Norway a quarter of all R&D is performed in the institute sector. Even in Iceland and Finland the public research institute sector has, alongside universities, a visible role in national innovation system. Iceland has a number of sector research institutes. In Finland there are altogether 19 government research institutes.

Co-ordination of innovation policy issues

The co-ordination of innovation policy making between sector ministries and agencies dealing with innovation policy issues is arranged in different ways in the Nordic countries. It seems that in many instances the development of co-ordination is lagging behind the otherwise vigorous thrust for innovation policy development taking place in the Nordic countries.

In Finland the co-ordinating role within the innovation policy field is played by the Science and Technology Policy Council. This government advisory body committee was established in March 1987 to continue, with a slightly different emphasis, the tasks of the Science Policy Council founded in 1963. The Council is chaired by the Prime Minister. Membership consists of the Minister of Education, the Minister of Trade and Industry, the Minister of Finance, four other ministers, and ten other members well versed in science or technology from public and private sector (the Academy of Finland, Tekes - the National Technology Agency, industry, and employers' and employees' organisations). The government appoints the Science and Technology Policy Council for a three-year term. The composition of the council ensures co-ordination for innovation policy at the highest political level possible.

The main tasks of the Finnish Science and Technology Policy Council include directing science and technology policy, dealing with the overall development of scientific research and education, and issuing statements on the allocation of public science and technology funds to the various ministries and fields. These guidelines and issue statements are made public in triennial key policy documents, in so called science and technology policy reviews. The reviews analyse past developments and draw conclusions and make proposals for the future.

In Iceland a new ministerial level co-ordination body, the Science and Technology Policy Council has been established by law. The council has replaced some functions of the former Icelandic Research Council. The layout of the new body resembles the Finnish model. The Icelandic science and technology policy council will be headed by the Prime Minister. Other members of the council are the Minister of Education, Science and Culture, the Minister of Industry and Commerce as well as the Minister of Finance. Furthermore 14 representatives of the science community have been nominated as council members.

An impetus for the reform of innovation policy co-ordination at the ministerial level in Iceland was the *OECD Review of Science, Technology and Innovation Policy in Iceland* in 1992. In the review it was recommended that Iceland should establish an inter-ministerial council on STI policy. The interest to establish such a council has been increasing in recent years. Apart from the establishment of the new policy co-ordination body there are also passed a new law for support for basic research and experimental development on one hand for support for technological development and innovation on the other. The law entered into force in the beginning of 2003.

Probably the most radical reform concerning higher innovation policy making structures has been implemented in Denmark. In connection with the change of Danish government in the end of 2001, innovation related policies and measures were transferred from the Ministry of Economic and Business Affairs to the new Ministry of Science, Technology and Innovation. At the same time part of the competence of the former Ministry of Trade and Industry regarding trade and business services and innovation related policies was placed with the Ministry of Science, Technology and Innovation. Furthermore, the administration of the university sector was alos transferred from the Ministry of Education to the Ministry of Science, Technology and Innovation.

In effect, this reorganisation has allocated all innovation related policies to the Ministry of Science, Technology and Innovation. The government expects that this transfer, in connection with other measures to be taken in the coming years, will contribute to a better co-ordination of innovation policies in Denmark. The creation of a new Council for Technology and Innovation points in the same direction.

In Norway the issue of co-ordination of innovation policies has been under discussion at different points of time. For example, a White Paper on industrial policies already in 1989 implied a stronger emphasis on inter-ministerial co-ordination of policies relating to R&D and industry. Historically formulation of Norwegian R&D policy, the core of narrowly defined innovation policy, has been based on the so-called sector principle, meaning that each ministry is responsible for promoting and funding research activities within their own areas. Main responsibility in the development of national innovation policies lays although in The Ministry for Education and Research, The Ministry of Trade and Industry and the Ministry for Local Government and Regional Affairs. Furthermore, the Ministry of Education and Research has had responsibility for the overall R&D policies, for funding large parts of basic science in the universities and colleges, and for co-ordinating sector R&D policies.

Co-ordination of innovation policy issues at the governmental level in Norway takes place in two high level committees focusing on science and technology policy related issues: the inter-ministerial Research Forum for Government Officials *(Departementenes forskningsutvalg)* and the Government's Research Board *(Regjeringens forskningsutvalg – RFU)*. The Minister of Education and Research chairs RFU.

The Swedish institutional system is characterised by relatively small Ministries. This implies that functions assumed by ministries in other countries to some extent fall under the responsibility of government agencies in Sweden. All ministries support research activities in their own sector over their own budgets according to the sector research principle. Yet, Sweden has not designed a formal innovation policy but has separate governance structure for research policy and industrial policy. The responsibility for the Industrial policy rests on the ministry for Industry, Employment and Communication, whereas the Ministry of Education and Science is responsible for research policy and also the embryonic innovation policy through the Swedish agency for innovation system, VINNOVA.

Reform of innovation policy structures

Lately, national innovation policy structures and institutions have been under close scrutiny in all the Nordic Countries. Governments and ministries have assigned commissions and evaluators to assess how the public structures of innovation policy field could be improved. Another critical question is the integration and co-ordination of different policies dealing with research and innovation activities. The pressure to reform deeply rooted institutional and governance systems of research and innovation policies has led significant reforms in innovation policy structures in all the Nordic countries except Finland.

In Finnish case the higher policy making structure and core institutional arrangements of R&D and innovation policies have been remarkably constant over the last two decades since the establishment of Tekes, the national technology agency in 1983 and the government advisory body the Science and Technology Policy Council in 1987. Over the years a number of changes have been carried out among institutions and agencies responsible for research and technology development or for company support services. Important changes were implemented during the first part of the 90s when the Academy of Finland and VTT (the Technical Research Centre of Finland) were reorganised. From the innovation systems point of view perhaps most important structural reform in the 1990s concerned the piloting of the polytechnic system and its establishment on a permanent basis. Overall, though, the development of Finnish innovation policy structures has taken place rather incrementally.

In the other Nordic countries the innovation structures have gone through much deeper changes, some of which are still to be implemented. In Sweden, the reorganisation of the structures for public funding of research and technology development and support to business and regional development, has followed two government bills presented in the spring 2000. The first bill, issued by the Ministry of Industry, Employment and Communications, outlined a new organisational structure for public support to business and regional development and the other, issued by the Ministry of Education and Science, outlined a new organisational structure for public funding of research and technology development. The reorganisation of public support to business and regional development involved some 15 organisations. After the reform the number of organisations was reduced to six. The new structure is to enable more focused public efforts in areas of strategic importance, greater efficiency, and a better adaptation to the needs of target groups. The new agencies came into work in the beginning of 2001.

On the research and R&D funding side the new Swedish Research Council was established. The council incorporates three separate councils for the humanities and social sciences, for natural sciences and technology and for medicine. This body is the largest actor within the new organisation of research policy. Also, two special research councils were set up: one in the area of working life and social sciences, and the other one in the area of environment, spatial planning and agricultural sciences. Another feature of the new funding structure is VINNOVA (the Swedish Agency for Innovation Systems), an organisation for promoting sustainable economic growth by fostering effective innovation systems in Sweden and by funding research oriented towards the need of industry, primarily at the universities.

A further novel element of the Swedish institutional structure is a Research Forum for dialogue among researchers, organisations funding research, the general public and others directly or indirectly concerned by the research performed. The aspect of co-ordination is also in focus for the proposal of widening the Research Advisory Board to include innovation related issues.

In Norway a cross-ministerial process, which aims towards a new holistic national innovation policy is under its way, and the Ministry of Trade and Industry is expected to present an action plan in connection with the national budget in October2003. The idea is to include all ministries in innovation policy development. The Government has also presented an evaluation of the structure of business-oriented policy instruments and institutions. The evaluation is focused on the future organisational solutions for public business services. Furthermore, the policy makers are looking into the mix of indirect and direct policy instruments and measures.

The above mentioned process has resulted in a decision made by the Norwegian government to implement an institutional reform among public organisations supporting business and regional development. The main objective is to gather together public measures supporting innovation and internationalisation within a single organisation.

The reform is to achieve this by incorporating three organisations – namely the Norwegian Industrial and Regional Development Fund (SND), the Export Council of Norway and SVO, The Norwegian Government Consultative Office for Inventors. Some undefined policy measures belonging to the Research Council of Norway may also be included. According to the government proposal the reform is based on fact that internationalisation, regional development and innovation activities are today more and more closely part of each other and therefore services catering for the issues should be bundled together. SIVA is strangely enough not included.

Another reform concerning the structure of the Norwegian innovation system is the plan to give counties more responsibility vis-à-vis policy measures targeting regions and districts. The Ministry of Regional and Local Affairs has decided to give the county administrators more influence over the administration and allocation of the ministry's innovation policy measures and funds.

In Denmark reform within public policy and R&D system is not limited to the reorganisation of ministries and their responsibilities but also include an extensive reform of the public research system. Over the years, various stakeholders have not been content with national research and innovation system, but have expressed their concern about its efficiency. It has been argued that the system in its present form is too fragmented to act as a framework for a coherent and efficient use of research resources.

Therefore the government has commissioned the Danish Research Commission to review the relevant legislation with a view to enhancing the efficiency of the entire research system. The results of the appraisal were presented in September 2001.

Based on the Commissions recommendations the Parliament and the Government embarked on a reform of the entire public research system in 2002, when a new Act on Technology and Innovation was passed. The Act is a manifestation of the fact that policy areas covering technology and innovation are assembled in the Ministry of Technology, Science and Innovation.

Furthermore a new body, the Council for Technology and Innovation, is set up to assist implementation of the new legislation. The council advises the Minister of Technology, Science and Innovation and is authorised to make decisions on a number of specific appropriation affairs. The council, whose members are appointed by the minister, is put together so that it represents those competencies deemed essential for viable innovation system. Furthermore the research advisory system is to be reformed, in order to ensure an optimal use of research resources. This comes about by simplifying the organisational structure of the advisory system and strengthening the management. The intention is furthermore to create a more open competition on research means not allocated as basic appropriations to institutions, and that a larger part of appropriations be channelled through the advisory system.

The Danish government has also initiated reforms concerning the government research institution and the university sector. The aim is to sharpen up the profiles of individual institutions and increase collaboration. A new Bill on National Government Research institutions as well as amendments regarding the individual institutions are to be presented in early 2003. Moreover a new University Act is prepared by the government, and according to the original timetable the Act will be come into effect in the beginning of 2004. As a new element -- in addition to research and education -- an active role in knowledge exchange, technology transfer and mobility will be added to the university mission.

Developing innovation policy priorities

In the 1980's the policy of large national research programmes targeting strategic areas were a common phenomenon in Nordic countries as well as in many other OECD countries. Launching of these programmes was based on judgement that selected technologies would be strategic for future technical development and for the competitiveness of national industries.

Large investments in the strategic research areas were also understood as means of supporting the development of new industries and diversification of national industry base. It was especially Japan, which was used as a point of reference when large scale national programmes were developed elsewhere. Because of Japan's success in economic and technological terms the Japanese organisational and institutional arrangements of that time became a “good practice” which was imitated by other countries (e.g.the integration of science, technology and industry).

In Norway in the 1980s, there was broad national consensus behind the idea to increase funding for a few selected technologies -- IT, oil and gas, new materials, biotechnology, and fish farming -- and to improve the co-ordination between public and private actors, such as companies, universities, R&D institutes, public agencies, etc., within selected technology areas. It was generally accepted that the development of new industries was the outcome of scientific and technological processes. The new industries were defined as “science based industries”. R&D became the core element of this industrial strategy, and the main supporters of the strategy were people closely connected to the R&D system. Therefore the R&D system played a central role in the re-industrialisation policy of the 1980s. The policy had two main objectives: to expand the R&D sector (public and private), and to improve the industry-research relationship so that more science-based industries could be established.

In Sweden programmes established in 1980s were targetingso-called generic technologies like micro-electronics, biotechnology and new materials. These technologies were judged to be of strategic importance for future technical development and for the competitiveness of national industries. In 1984 a national micro-electronic programme (NMP) was initiated, which included huge R&D investments, support for product development and promoting co-operation between universities and industry. Government and industry jointly financed the programme. The generation of the new technology was heavily dependent on investments in basic research, applied research and development activities. Later in the 1980s NMP was replaced by the IT4-programme.

Analogous development took place in Denmark in the 1980s. Large scale research programmes targeting hi-tech areas were introduced first by the Conservative-Liberal government in the early 1980s. Beginning with an IT–programme and shortly after passing initiatives in biotechnology, materials and ending in food technology the next ten years were dominated by such programmes. The most interesting feature with these programs were the relative large amounts of money transferred into these every year during time spans of 6 – 10 years even though the programmes formally had duration of 3 – 4 years but they were prolonged one or two times during that phase.

Tekes, which was established in 1983 as key agency for new technology-oriented policy, adopted concept of technology programmes into its service and instrument portfolio. At the time of the launching of the programmes it was thought that the new instrument would enable Tekes to control publicly funded R&D activities. The first of Tekes' programmes were focused on information technology and this emphasis continued until the late 1980's, even if the share of information technology in Tekes funding had been decreasing during the last part of the 1980s. First national technology programmes relating to information technologies were in fact launched already in the end of previous decade. The one dealt with solid state technology and the other with information technology.

Icelandic research policy was going through a transformation in early years of the 1980s. Up until then the nation's research and development efforts were overwhelmingly preoccupied by research and exploitation of natural resources on land and in the sea. In 1981 the focus of the National Research Council shifted towards policies, which were more technology and human capital orientated. At the same time more attention than ever before was paid to the role of private companies and their involvement in R&D activities. Since then industry's interest and share of national R&D expenditures has been rapidly growing.

Even if there were no large scale Icelandic research programmes in the 1980s there were nevertheless some visible priorities. It is of a great interest that Iceland started to pave the way for the present biotechnology development in the 80s by, for example, allocating some 45 per cent of the available funds to that field. These investments made it possible to educate people in biotechnology and carry out research projects.

Turn of the 1990s - redefinition of priorities

Until the turn of the 1990s Nordic countries were following familiar paths in development of science, technology and industrial policies. The late 1980's and the first years of the following decade were in many Nordic countries a time for strong economic fluctuations and increasing socio-economic problems.

The economic downturn hit Norway as a result of the falling oil prices in 1986. That was followed by the stock market collapse in 1987, the bankruptcy of the high-tech national champions Norsk Data and KV in the years 1987-89, rapid de-industrialisation, increased immigration from the periphery to the centre, collapse of fishing resources and the fish farming industry, collapse of the national financial system, the highest unemployment figures since WW2 and social problems for large groups of people because of debts and high interest rates. The difficult period between 1986-1993 was clearly defined by politicians as a ”crisis”. The perceived emergency led to a departure from the “best industrial structure” orientation, which had prevailed in Norwegian industrial policies since the Second World War; old ideas and institutions were abolished, new ones were introduced.

In Finland and Sweden the economy was still growing during the late 1980s, and the Finnish unemployment rate was at a record low level in 1989-1990. Strong optimism and dynamism was characterising the Finnish economy of the time – the financial markets had been deregulated some years earlier, the stock indexes were climbing and people had the confidence to aquire bank loans and mortgages. However, everything was turned upside-down in short period of time. The Finnish economy plunged into very severe recession in the beginning of the 1990s. Between 1990-1993 gross national product figures dropped by 13 percent; the national currency, the markka, was devalued by almost 40 percent and unemployment peaked near to 20 percent. The banking system was also in a serious crisis and this eventually led to the bankruptcy of ne bank and new alignments and mergers between the remaining banks. This negative economic spiral had a deteriorating effect on state finances, because at the same time as tax income dropped the need for public expenditure rose. This, in turn caused both a growth in the state budget deficit and in external debts.

The challenges faced by Sweden and Finland were in many ways similar. The economic slow-down in the early 1990s caused increasing unemployment and budget deficits in Sweden. In 1991 the social democrats lost the elections and a centre right-wing government came into power — parallel to what happened in Finnish domestic politics after the 1991 elections.

Overall, with hindsight it is possible to see that even if the Nordic countries all are small and internally open economies and societies, the economic crisis and later slow-down in economic activities had different trajectories. In Denmark the crisis began immediately after the first oil crisis 1973/74. In 1973 the rate of unemployment in Denmark was 1.1 percentI, in 1975 6.0 percent.

Dissemination of the systemic approach

The economic upheavals caused the drafting of new national industrial strategies. Norway's industrial strategy was written anew by the Brundtland government, which was in power 1986-1989. The strategy laid down priorities for the national industrial policy in coming years. Priorities included “healthy” macro economic conditions, the need to expand the industrial policy focus beyond the manufacturing industry, less direct support to most indusries and a de-centralising of instruments for industrial policy. Moreover, local communities and regional authorities were made responsible for development.

The Norwegian government argued that the number of instruments available for industrial policies were rather limited. International agreements put a limit to the type of instruments, which could -- formally -- be used to shape industrial development. The government defined several main areas for governmental intervention, including R&D, technology and competence development, and capital supply (especially venture capital).

The Norwegian policy of the late 1980s in Norway was focused on the development of a new basis for future welfare, which should be carried through a modernisation of the whole economy. It was argued that the Norwegian economy was too dependent on oil revenues and natural resources, and that long term welfare would require a successful transformation towards less resource based productions. Therefore, the government’s long term plans from the late 1980s argued for the need to transform the national economy and ensure a radical structural change. The main difference from the policies of the earlier 1980s was that the government now declined to indicate how the structure of the future economy ought to be.

In Finland the government launched the preparation of a new national industrial strategy in 1992 in midst of the deep recession. The strategy was drafted and written within short time span from autumn 1992 to spring 1993 and it aimed among other things for an adoption of modern industrial policy thinking, which could target Finland's problems and strengthen the position of the Ministry of Trade and Industry in industrial policy-making. Theoretically the strategy formulation rested on Porter's competitiveness model which was thought to offer “a natural framework for contemplation of a new industrial policy".

The redefined strategy made a clear distinction between the old and new industrial policies. The old industrial policy was seen to rely too much on direct firm subsidies as well as regional and sector subventions, which were not promoting the birth of new economic dynamics but instead was supporting uncompetitive activities. Furthermore, the old approach was seen to rest on untenable assumptions concerning the competences of public policy makers and their ability to plan and steer structural development of industries. The new industrial strategy meant “the end of having a dispersed system of supports and financial aid”.[4]

[4]National Industrial Strategy for Finland (1993) The Ministry of Trade and Industry, Industry Department (Matti Pietarinen, Risto Ranki). Ministry of Trade and Industry publications 1/1993.

The juxtaposition of the old and the new way of thinking was apparent even at the level of policy goals: “the goal is not the reallocation of current resources but rather the influencing of quantity and quality of resources to be born in the future”. The new guidelines of industrial policy promoted structural changes indirectly by targeting the areas where markets are working insufficiently, by utilising external effects of investments into R&D, by developing production factors - mainly know-how and research - and by advancing working of markets.

The redefined industrial policy strategy was in line with the ideas put forward by the Finnish Science and Technology Policy Council a few years before. The council had laid the groundwork for a “new” science and technology policy as published in its review in 1990. The concept of a national innovation system was introduced into Finnish policy making in this policy document. The concept offered a framework within which it was possible to take a broad and systematic approach to policy making and concerning “a whole set of factors influencing the development and utilisation of new knowledge and know-how”[5].

On other side of the Baltic Sea the Swedish centre-right government was also designing a policy response that was to turn the slow-down of the early 90s into economic growth. The government's strategy was built on policies targeting an increasing international competitiveness of the Swedish industry. The emergence of the IT-revolution and of a “knowledge society” -- including increased knowledge content of products and services – were identified as important global trends which significant policy implications.

In this situation the government saw its responsibility to be the creation of favourable framework conditions for the transformation of society. This meant among other things supporting the development of high-tech industries. These industries are dependent on a well-functioning infrastructure including a public research system. Therefore, the role of research was to develop new fields of knowledge so that it could contribute to the renewal of industry. The link between research policy and growth policy was explicit; the task to support the competitiveness of Swedish industry became the prime task of research policy.

It was in this context the concept of innovation policy -- i.e. the fostering of economic growth and the competitive power of national industry by creating favourable conditions for innovative activities -- entered the Swedish policy arena. The concept of innovation systems, and especially national innovation systems, began to spread in the policy debate and in policy thinking in the late 90s.

At the end of the 1990s a policy reformulation took place against the background of comparatively slow economic growth and increasing regional economic imbalances. The government presented two major strategies for turning these trends. The first one focused on creating increased economic growth by increasing the co-ordination of industrial and research policies, which manifested itself in a considerable reorganisation of the public research funding structure in January 2001. The challenge of regional

[5]Review 1990 – guidelines for science and technology policy in the 1990s (1990) The Science and Technology Policy Council of Finland.

imbalances was meant to tackle by implementing so called “regional growth agreements”.

Overall, the 1990s constituted a period when there was in many countries a quest for a more systemic approach in the development of policies related to science, technology and industrial development. For instance, in Norway the idea of an innovation policy was for first time explicitly presented in a White Paper on research policy in 1993.[6] The direct impact of this document was relatively weak — it did not give an impetus for broader debate, nor did it lead to any substantial increase in national investments in R&D. Some elements of broader approaches were, though, involved in the establishment of new body, the Research Council of Norway in 1990. The Research Council was given a strengthened and formalised agenda that went beyond the role as a classical research council cum funding agency. Besides being a research council in the established sense, the new body was given the explicit task of being a central policy formulating and advising body for national R&D and innovation policies.

In Norway and Denmark, just as in Sweden the real breakthrough of innovation systems thinking at the policy-making level took place in the latter half of the 1990s. A Norwegian White Paper on research policy published in 1999 was to a large extent structured around innovation theory.[7] The White Paper contained an analysis of the whole Norwegian knowledge system, from university and college research to industrial innovation activities. It recommended that national R&D funding should reach the OECD average, measured as a proportion of GDP, in the course of five years. This goal was later affirmed by the Norwegian government. It further argued that a main priority in the use of public funds should be the strengthening of long-term fundamental research, and priority should be given to increased research commitment in the fields of marine research; information and communication technology; medical and health-care research; and research in the area of intersection between energy and the environment.

The changing rationalities of R&D and innovation policies emphasising innovation based growth have not though totally wiped out “old” political concerns. This is especially true in relation to the position and importance of large companies in such small and open economies as in Nordic countries. Such concerns usually surface when a successful national company are sold abroad or a large company decides to relocate its headquarter or significant R&D units abroad. Also, changes in economic performance of large companies, which are in many sense industrial locomotives, tend to be quickly reflected in small economies —for better or worse.

The growing importance of international co-operation

International interaction and collaboration is essential issue for small countries like the Nordic ones. The limited size of domestic market drives growth oriented or niche market companies to internationalise their activities at a very early stage. In addition, the small size of a country often correlates with rather specialised industrial structures and exports. SME dominated and specialised industrial structures tend to make the economies of small countries sensitive and vulnerable to external developments. At the

[6] St. meld. nr. 36 (1992 – 1993).
[7] St. Meld. nr. 39 (1998 – 1999).

field of science and technology policy, small size may cause extra challenges especially with respect to the availability of resources.[8]

Against this background it has been in the Nordic countries' interest that international research collaboration has grown rapidly during the last few decades. This development has opened up new horizons, increased cross-border networking and enabled pooling of resources for common goals. The European Union Framework Programme is today probably the single most important measure, which supports cross-border pre-competitive research collaboration between research organisations and companies in Europe. The Framework Programme is open not just to the EU member countries but also to other European, non-EU countries. This means that all the Nordic countries can participate in the Framework programmes, as they have also done with good track records.

A recent Finnish study[9] revealed that the participation of universities in the European Union Framework programmes has had a positive impact on international research co-operation and has increased international visibility of Finnish research. Furthermore, the collaboration with companies has increased awareness among academics of the commercial use of research results. These results are well in line with current innovation policy aspirations in Finland.

Another study[10] assessing impacts of the Fourth Framework programme found that Finnish firms collaborated more with universities and research institutes in the framework programme projects than in their R&D activities in general. It was concluded in the study that the promotion of cross-sector collaboration has been an important added value of the framework programme.

Another important finding was that projects in industries with the lowest R&D intensities had the largest additionality. These result indicates that the EU Framework Programme concept has succeeded in promoting R&D activities in companies that perform little R&D themselves.

The study further confirmed an earlier finding that framework programme collaboration plays a different role for different research sectors. Thus the EU project was of strategic importance for research performing institutions, government research institutes and universities, and SMEs. For large companies and non-profit organisations, it was most often of potential future importance. For all research sectors, EU funding is important in enabling them to carry out cross-country collaborative projects.

Apart from the Framework programme the EU Structural Funds Programmes encourage innovation and knowledge based growth in areas that are lagging behind. The

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[8]Elina Berghäll et al. (2002) The Role of Science and Technology Policy in Small Economies. Valtion taloudellinen tutkimuskeskus (Government Institute for Economic Research). VATT-Research Reports 91.

[9] Niskanen, Pirjo (2001) Finnish universities and the EU Framework Programme - Towards a New Phase. VTT Group for Technology Studies. VTT Publications: 440.

[10] Luukkonen, Terttu; Hälikkä, Sasu (2000) Knowledge Creation and Knowledge Diffusion Networks - Impacts in Finland of the EU's Fourth Framework Programme for Research and Development. Tekes, National Technology Agency. Publications of the Finnish Secretariat for EU R&D : 1/2000

motivation for the programmes comes from the treaty establishing the European Community. The Treaty lays down the principle of economic and social cohesion, under which every effort is made to reduce disparities between the levels of development of the various regions. Under-developed and declining regions are assisted through regional and structural policy measures financed by the EU Structural Funds. The Structural Funds Programmes cover, however, only the EU member countries, which in the Nordic context leaves out Iceland and Norway.

A current trend is that an increasing share of the Structural Funds resources is deployed in the EU countries for economic development and innovation policies. A Finnish study[11] analysing the impacts of the EU Structural Funds on regional innovation activities confirmed that regionally the structural support has been an important additional resource, which has complemented national R&D and innovation funding.

The regions eligible for the structural support are typically getting only a small share of national research and technology development financing. The additional input has supported the strengthening of regional innovation environments. It has had also positive impact on the networking between participating firms, and between firms and technology centres, universities and research institutes. Furthermore, the study showed that the Structural Funds programmes have had an effect on Finnish innovation policy-making. The latter effects were most visible in the range of policy-makers and in working practices at the regional level. New actors, who have not been active in this sector before, have entered the field of technology policy and become involved in design its regional contents and aims.

As a whole the significance of international co-operation in research and innovation will without doubt increase in the future in Europe as well as in the Nordic countries. The topic is currently high on national innovation policy agendas, like in Finland. At the EU-level the development towards more integrated European research and innovation policies is a cornerstone of the European Research Area (ERA). The EU has identified two broad objectives to improve innovation in the community context: strengthening the bridge between research and innovation and secondly renewing the human potential for research. What clearly seems to be at stake here is the strengthening of interaction between research community and other innovation actors and enhancing working of knowledge transfer between actors. The second policy proposal concerns need to improve and enlarge knowledge base continuously.

[11] Kuitunen Soile & Oksanen Juha (2002) Mikä rooli EU:n rakennerahastoilla on alueiden innovaatiotoiminnassa ja innovaatiopolitiikassa (Role of the EU Structural Funds in Innovation Activity and Innovation Policy of the Regions). Ministry of Trade and Industry: Studies and Reports 10/2002.

Main components of public innovation policies in the Nordic countries

Innovation financing

In this sub chapter will be offered a description on research and development and innovation financing in the Nordic countries. For a more detailed analysis of relevant innovation policy indicators, see report no. 1.

As regards certain main features of R&D financing the Nordic countries differ from each other.When comparing total investments in research and technology development it is Finland and Sweden which invest most in R&D as a percentage of GDP. Currently, alongside Japan the two Nordic countries occupy top positions in international comparisons.

Sweden has a long track record as regards internationally high R&D expenditures. Finland's spending on R&D was until the early 1990s under the OECD average, even if the trend was a constant growth ever since the 1970s. It was during the second part of the 1990s that Finnish R&D spending grew especially rapidly. As regard the other Nordic countries, Denmark and Iceland’s investments in R&D is around the OECD average, while Norway is below. However, during the 1990s Denmark was allocating a steadily growing proportion of its resources to R&D activities. In Norway's case the volume of R&D expenditures as percentage of GDP has stayed more or less intact for a longer period of time.[12]

Furthermore, the Nordic countries are different from each other as regard the composition of R&D inputs. In Finland and Sweden the enterprise sector stands for majority of the R&D expenditures — in the recent years the private sector has covered over 70 per cent of all R&D inputs in the both countries. This means that a large part of new knowledge and new technologies is produced outside academia or other public research organisations. The situation is different in Iceland and Norway, where the government is the main source of funding. In Iceland also foreign funding plays an important role. Denmark could be placed somewhere in between these two groups.

Key trends in public innovation finance in Nordic countries

During the last decade one of the most prominent trends of Finnish innovation policy has been the rapid increase in both public and private research funding. In 1991 R&D expenditure accounted for 2.1 per cent of GDP, whereas in 2001 the figure was 3.4 per cent of GDP. The increase is mainly explained by increased R&D investments in the business sector. Also the government input rose markedly particularly within the second part of the 1990's. This was largely because of the Government additional research appropriation programme implemented in the late 1990s. Part of the resources gained from the privatisation of the state companies was channelled to R&D activities. As a result of the additional research appropriation programme Finnish government spending on R&D rose by FIM 1.5 billion (around € 250 million) between 1997 and 1999.

[12] For a more elaborate description of Nordic national R&D investments, see GoodNIP report no. 1.

After the end of the additional funding programme the government input into R&D has stayed almost intact for last couple of years. Because of this the public share of total R&D expenditure has continued to diminish. This situation has caused concern among innovation policy actors. The Science and Technology Policy Council has explicitly stated in its Review 2003 that the level of public research and development and innovation financing should be raised from 2003 to 2007 by a total of € 405 million. This is seen as an essential step in order to speed up the internationalisation of the innovation system and to further develop innovation in Finland.

The Science and Technology Policy Council has lifted up three main targets for the development of funding. The first concerns education, the development of research careers and broad-based increases in researched knowledge, the second, the strengthening of social and technological innovation and the third flexible, expert development of innovation funding.

All in all, the new recommendation of the Science and Technology Policy Council is well in line with long standing Finnish R&D and innovation policy approach: during the last three decades Finnish science and technology policy has often been expressed through targets set for the growth of R&D expenditure in relation to GDP. International statistics on R&D expenditures, usually produced by the OECD, has over the years served as an important base for the setting of quantified targets. However, this time the growth target for the public R&D financing is not defined against an international yardstick, but as the GDP share of government research funding — the goal is to lift public R&D expenditures over 1 per cent of GDP.[13]

In Norway, public funding for industrial R&D has had played major role in innovation policies throughout the last two decades. In the early 1980s up to 1986 corporate funding was still increasing more rapidly than public funding mainly because of R&D funded by oil and gas companies, which was to dominate substantial parts of the industrially oriented research system. However, the collapse of the price of crude oil on international markets in 1986 affected negatively the profitability of a range of oil and gas fields off shore. As a result of this industrial R&D related to exploration, construction of production facilities etc. was rapidly scaled down.

At the turn of the century a need to allocate more public resources towards R&D re-emerged on Norwegian policy agenda. Government assigned expert commissions have stressed the need for an increase in public investments in R&D. The government has also set as a national goal that Norway should reach the OECD average level of R&D expenditures (as measured percentage of GDP) by 2005 as the latest.

The need for strengthening of the national investments in R&D have been advocated by pointing to concepts like “the new economy”, “the knowledge society” or “the information society”, based on a feeling that Norway ought to invest more in high-tech

[13] Lemola Tarmo (2001) The Role of Science and Technology Policy in Finland's* Economic Development. Portland International Conference on Management of Engineering and Technology. Portland, OR, 7 July - 8 Aug. 2001

industries and ICT. It has also been argued that the State invests too little in basic university research. The debate has shown, however, that few have any clear concept of what is meant by a “knowledge society”.

The current Icelandic innovation policy strategy is to strengthen the role of the university sector in underpinning the “knowledge based society” while holding the public support to public laboratories performing research relating to traditional economic sectors constant. The exception is that funds targeting research in marine environment and fisheries management related research are to be increased, reflecting concern over the sustainability of marine fisheries.

The government decided in early 2001 to award additional funding to university research. Simultaneously a decision was made to award additional funds for the next three years for the Science Fund and the Graduate Training Fund under the Icelandic Research Council. Out of these 1/5 will go to the Graduate Education Fund. This reflects a policy to give higher priority to basic research and graduate training meeting the strong interest of the university sector to expand in this direction.

When discussing the public funding of research the question of a critical mass of activities cannot be avoided. In all small economies the pressure to target limited R&D resources strategically is a question of high relevance. The Icelandic Research Council Rannis had been criticised for allotting to small resources and having too stringent procedures. As a response the Icelandic Research Council redesigned its grants policies for 2002 by creating a new scheme of a limited number of substantially larger grants for excellence from its Science Fund. Funding requires scientific teams and matching institutional funding. This type of funding is partly intended to match other international schemes to support Centres and Networks of Excellence.

In Sweden the public R&D and innovation financing was growing during the first part of the 1990s. At that time was also established a new element into the Swedish system: The centre-right government in power established new research foundations, through which the public funding was mainly channelled. The foundations were established by liquidating the so-called wage earners funds and transferring the capital to a number of new research foundations. The objective of the foundations’ funding was to promote the emergence of new industries and thus future economic growth; their funding of university research should improve the long-term competitiveness of Swedish industry. The objective should be achieved by investments in long-term research and in training of new researchers in strategic technology fields like IT, biotechnology and new materials.

The argument for using foundations as the instrument for achieving these goals was that foundations supposedly are more flexible in relation to the needs of society. Another reason was to protect the funds from political manipulation: future Governments should not be able to liquidate them even if they wanted to. The new research funding model meant that the influence of policy on the direction of research decreased. Large-scale, offensive and multi-disciplinary research investments in strategic technology fields were managed outside the policy domain.

After the mid-1990s the tide turned in Swedish R&D financing and issue was savings and budget cuts in public research funding. A reason for the rethinking was the worsening situation of state finances in a period of economic recession. The former government's decision to increase public R&D funding substantially were partly fuelling increasing budget deficits.

A consequence of the saving measures was a changing relationship between public and private research funding. The public resources funnelled through research councils concerned investments in the infrastructure of research, while the private funding by foundations concerned strategic research investments. This was an unintended consequence and led to a “privatisation” of research policy. An issue for the Labour Government in the second half of the 1990s was to try to control the research funding of foundations and to co-ordinate their funding with other public funding. However, the Government never succeeded in controlling the foundations. Co-ordination of research funding was to some extent achieved through agreements with the foundations instead.

Tax concessions

An area where the Nordic countries diverge from each other is the use of tax reduction schemes in order to promote R&D in companies. Such schemes are currently in place in Denmark and Norway but not in Iceland, Finland or Sweden. In 2002 the Danish Parliament passed an amendment to the tax legislation making it more attractive for companies to invest in research and development. The instrument is a 150 per cent tax deduction on expenses incurred in research projects co-financed by Danish public research institutions. The arrangement is temporary, being effective in 2002 and 2003.

Norway has also recently introduced a tax deduction scheme (SkatteFUNN), which originally was meant for smaller firms with less than 100 employees. From the beginning of 2003 the scheme is open to all companies, regardless of size. Still, SMEs are eligible for a 2 per cent higher tax reduction of total project costs than are larger companies. There is a ceiling, which limits the amount of maximum tax reduction per year. Research and development is defined as a limited and goal oriented project that is to generate new knowledge, information or experience that will be of use for the company in the development of new or improved products, services or methods of production.

In the past other countries have also tried out tax concessions as a way to induce R&D. For instance, there was for a while in the late 1980s a tax reduction scheme for R&D in Finland. This measure was however soon abandoned , because the authorities came to the conclusion that the benefits of the tax concession were not high enough compared to the scheme’s administrative costs and other expenses. In addition, the scheme was seen to contradict the Government's goal to simplify taxation by eliminating the number of concessions.

Besides the tax reductions for R&D, there are nowadays tax schemes which aim to alleviate employers' problems with recruiting key staff members from abroad. A Danish scheme introduced in 1992 covers so-called immigrating key staff members -defined as persons with monthly income above € 7,000 in 2002 - who can choose to be taxed at 25 per cent of their gross income during the first three years, and the following years be taxed on a normal basis. However, if the person after an additional four years decides to stay in Denmark, he will be taxed to neutralise the tax benefit obtained in the first three years.

Similar kinds of schemes are or have been in place in other Nordic countries as well. In Sweden a special time limited tax reduction for visiting scientific experts was introduced in January 2001. In Finland a fixed-term tax scheme for key staff members immigrating from abroad was in operation in the years 1996-1999, and after one year interruption was continued in the period 2001-2003.

Still another tax related solution is tested presently by the Icelandic Government, which made a decision to lower general corporate income tax from 30% to 18%. This decision, which came into effect in 2002, is supposed to have a positive effect on firms' willingness to invest in technology based industrial projects and even in R&D activities. Overall, the tax reduction is seen to be an important countermeasure at a time when an economic downturn is reducing the availability of and access to private risk capital. The tax reduction is also expected to reduce the risk of successful Icelandic high-tech companies moving their domestic operations abroad in the future. Furthermore, the lowering of corporate income tax to internationally competitive level may attract foreign investments in technology based industries. It may also further strengthen the interest in R&D and high-tech based spin-offs and growth in companies.

Venture capital for R&D and innovation activities

Fine-tuning of taxation is not the only way to increase private investments in R&D and innovation. Governments are today increasingly recognising that private investors, business angels and venture capital corporations have a key role to play in the near-to-market phase and commercialisation of innovation. The importance of these actors goes far beyond pure financing of promising innovations - for example, business angels are through their business experience and know-how and personal contacts invaluable source of advice for start-ups and entrepreneurs.

Until recently the venture capital markets in many countries have, however, been quite underdeveloped. The situation has changed markedly in the aftermath of the ITC-boom of the late 1990s, during which the number of wealthy individuals and professional venture capital organisations increased substantially.

Among the Nordic countries it is Sweden that has experienced the strongest development in financial markets. The Swedish venture capital industry is today one of the largest in the OECD in relation to population. Growth in the venture capital market has been coupled with the development of new markets focusing especially on innovative firms. Foreign venture capital investors and corporate finance brokers entering Sweden have also improved the financial climate for small, mainly technology based firms in early stages of development. Lately, however, the global economic down-turn has had an adverse effect on venture capital markets in Sweden as well as in other countries, and the amount of seed capital invested has decreased substantially.

The Swedish public sector has actively been involved in the development of financial measures targeting companies and entrepreneurs in different phases of businesses. For example, a public seed finance scheme was launched by NUTEK in the mid 1970s. This long lasting seed finance scheme was replaced by a new arrangement in 2002, when a new service was established to offer advice and finance to technology based firms in the early stages of development. In the 1990s some new institutions were established in Sweden in order to help bring together independent inventors and resources for market exploitation.

SIC, Stiftelsen InnovationsCentrum, founded in 1994, is a public foundation with the objective to foster innovation through grants, loans and advice. It focuses on inventions and inventors in the very early stage of development – the pre-seed or seed stage. Financing is also given to projects aiming at developing product prototypes. Separate from NUTEK and SIC there is a third state-owned actor, the Swedish Industrial Development Fund, providing conditional loans for development projects in industry as well as new equity through its venture capital branch. A relatively new pension fund controlled by the Government - The sixth AP Fund (Sjätte APfonden) - has been formed with the mission to engage in venture capital via actors established in the field.

According to a recent study the developments of the venture capital markets in the other Nordic countries have followed diverse paths. In Finland the risk financing market has developed rapidly and is generally functioning well in quantitative terms. Also public initiatives to stimulate the growth of the private market have proven successful. The study maintains that "political priorities for stimulating the development of risk capital market have been higher than in other Nordic countries". In Finland, the market development is based on large allocations of public resources to financial programmes and contributions to industrial research. [14]

The above mentioned study of developments in Nordic risk financing notes that Danish venture and seed capital markets are still relatively small and immature by European and Nordic standards, even though there has been a remarkable development in the last years. A distinctive feature of the Danish risk capital markets is lower public involvement than in other Nordic countries. The volume of public funding to initiatives aimed to stimulate new technology based firms' risk financing is also identified to be low in Denmark -according to the study this is partly explained by a lower political priority given to these areas than in other countries. Also, the study points to "a Danish tradition of limited government involvement in the business sector relative to the other Nordic countries". The Innovation Environment programme initiated in 1998 and two nation-wide seed capital funds established by the Business Development Finance in 2000 are lifted up as good examples.

As in the case of Denmark, the venture capital and private equity markets in Norway are deemed in the Nordic comparison to be relatively immature. Investors are focusing mainly on "later stage investments in traditional industries, implying an emphasis on low risk investments in the industry". Characteristic of the Norwegian seed capital market is the predominant role of government funding and public initiatives.

However, Norway has recently paid more attention to possibilities to stimulate private financing of R&D activities. A commission which considered this question proposed that companies that invest in certain types of R&D projects involving universities, colleges and certain R&D institutes should get concession of the expenses covered by the state. Furthermore, the Norwegian Minister of Education and Research has organised an informal meeting for invited industrialists and capitalists in order to discuss of the potential to establish private funds for R&D.

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[14] *Seed Capital in the Nordic Countries: Best Practice.* A report prepared for the Nordic Industrial Fund (2002)

Promotion of clustering and networking

The extension and strengthening of networks of co-operation between innovation actors is seen as one of the key questions in the development of science, technology and innovation policies in various countries. This also holds true for the Nordic countries. The development of connections between companies, research institutions, universities and other educational institutions is an explicit objective of various national innovation policy instruments. Usually these measures are co-financed by public agencies and participating organisations/companies.

The current emphasis on the advancement and encouragement of networking is evident in official innovation policy documents and publicly stated intentions of the governments. For instance, the Danish Government has recently announced that it in 2003 will present a coherent action plan to further strengthen co-operation between trade and industry and knowledge institutions. The action programme will be focusing especially on opportunities and incitements to establish mutual co-operation both among and between knowledge institutions and enterprises. Central issues will be the future interface between the technological service system, science parks, incubators, and the government research institutions on the one hand and trade and industry on the other.

Instruments to strengthen companies' access to knowledge and competences will also be given priority – new and small enterprises are given special mention. The steps already taken towards a reform of the entire research, university, and innovation system (including the institutional and management reform of universities and the reform of the research advisory and funding system) are part of this action plan. The purpose of the reforms is to provide for a more transparent and accessible research and innovation system together with a strengthening of co-operation across institutions.

All in all, there are a number of Danish initiatives aiming to induce networking and co-operation between universities, research institutions, companies and technological services: "Innovation Consortiums", the Centre Contract Scheme, the Approved Technological Service Institutes (GTS institutes), the Innovation Post-Doc Scheme and Regional Growth Centres.

An interesting example is the Innovation Post Doc programme which focuses on younger researchers within all research areas, and facilitates co-operation between public research institutions and private companies. The means is a so-called post-doc scholarship given to researchers having a maximum of 5 years research seniority or a PhD degree. It is a prerequisite that a formalised co-operation with one or more companies is established, but the researcher will be employed at a university, a hospital or a public research institution.

In Norway there is a wide palette of public policy instruments supporting networking between different actors. For instance, the public user-oriented R&D programmes aim deliberately at strengthening the collaboration between firms and universities, colleges and R&D institutes. Other Norwegian measures pursuing strengthened co-operation include the NT-programme, which is to develop networks between companies and knowledge institutions in Northern Norway, as well as FORNY (Science and technology based innovation), TEFT (Technology Transfer from R&D Institutions to

SMEs), and the 'umbrella' programme MOBI (Mobilisation for R&D related innovation).

There has been little emphasis on cluster development and networking in Iceland until recent days, even if there are two official clusters in the country, one in the area of fisheries and the industry serving fisheries, the second in the field of health technology. These two clusters have been very successful. The clusters were designed by the Federation of Icelandic industries. There are other informal clusters in various forms, but they are working in a rather narrow industrial base.

In Finland a number of projects and initiatives have been created to promote cluster formation and networking. Recently, there have been two major initiatives to promote cross and intra-sector collaboration in particular. The first initiative, the Centre of Expertise Programme, is a national measure that aims to enhance regional competitiveness by strengthening innovation, renewing the production structure and creating new jobs within the expertise areas selected. The second initiative, the Cluster Programmes, aims to support R&D activities that strengthen clusters and collaboration between industry and public organisations, and company to company co-operation including user-opinion. In a recent evaluation, an expert group recommended that clusters should be extended to new areas and that the existing clusters need to be more focused.

Impact of research programmes on networking

Several studies and evaluations have concluded that co-operation and interaction between different parts of the national innovation system has developed favourable during the last 10-15 years in Finland. Over the years the single most important ongoing activity promoting co-operation has perhaps been Tekes’ technology programmes. A new programme concept was launched in the mid-1980s and from the beginning the new instrument was not only meant to channel public funding but also to draw together and strengthen co-operation between universities, government research institutes and companies. Also, gaining new technology expertise and product development options in the important business areas of the future has been an important aim of the technology programmes from the beginning.

The significance of the Tekes programmes as catalysts for co-operation in Finland is strengthened by the fact that it is Tekes that controls the by far largest share of public funding available for technologically oriented R&D. When evaluating funding applications Tekes takes a positive view of projects that involve networking with other companies, joint ventures, the contracting of services from Finnish research institutes and universities and the promotion of international co-operation. In the case of larger companies, one of the criteria for funding through the technology programmes is networking and the use of SME subcontractors.

There has also been a significant qualitative change: Earlier the projects funded in programmes were more often based on bilateral co-operation, but today multilateral co-operation is prominent. Co-operation is also integral part of the development of new programmes: They have been created with the needs of companies in mind, and have been implemented in collaboration with companies. The planning takes place in workgroups and seminars involving firms, universities, research organisations and industry associations etc., and the explicit aim of the programmes is the promotion of collaboration between these parties.

Comparable programmes are administered by VINNOVA of Sweden, which finances and promotes research mainly through programmes and projects that are organised as joint efforts between industry, academia and research institutes. However, in contrast to many other countries most R&D programmes in Sweden are aiming at increasing the competence level in university research and not directly supporting R&D activities of companies.

The Swedish Competence Centre Programme is an effort to build bridges between science and industry in Sweden by creating excellent academic research environments in which industrial companies participate actively and persistently in order to derive long-term benefits. The mission is to strengthen the crucial link in the Swedish national innovation system between academic research groups and industrial R&D. The overall programme goal is to prove that universities are able to become real resources for Swedish industry and thus to fulfil the tasks that in many other countries are managed by public research laboratories or institutes.

Programmes focusing on clusters or regions

Promotion of networking is an integral part of the public programmes and measures which focus on cluster development, regional development or both. In many countries public measures and initiatives have been created to promote collaboration, transfer and utilisation of knowledge within a cluster or a region. Swedish Regional Growth Agreements include rather explicit cluster development ambitions, although the approaches and degree of concreteness vary considerably between regions. In some regions, rather ambitious cluster development activities are underway. Lately, several other measures with an explicit cluster approach have been launched.

The Swedish Government has established a national programme for the development of innovation systems and clusters. The programme will carry on from 2003 to 2005 and the aim is to strengthen and complement already ongoing activities at regional level to improve the regional competitiveness.

VINNVÄXT (Regional growth through dynamic innovation systems) is another Swedish programme, which ties together innovation promotion and regional development. The aim of VINNVÄXT is to stimulate strong innovation systems with qualified environments for research and development as well as regional competitive and dynamic networks in order to achieve more innovations and lasting growth.

The concept behind the programme is the promotion of effective co-operation between companies, research and development organisations and the political system (the triple helix) within each region, with the aim of developing dynamic regional innovation systems, which will allow the region to be competitive on an international level within specific areas of growth.

VINNOVA offers support for process management and competence development in these specific areas. Selected regions (5-10) will have the possibility to receive financing during ten years but will also be evaluated regularly. The outcome of the evaluation decides if the region will have the possibility to receive further financing.

In the present research policy debate in Sweden support of existing research clusters is considered to be highly important. Even though they have not been developed specifically for this purpose, the Regional Technology Programme, the New Liaison Functions, Technology Transfer for SMEs –TUFF and Active Industrial Collaboration could be considered as potentially conducive to cluster formation.

The Finnish national cluster programmes is another instrument representing a model for public support for collaboration between public and private sector partners. The cluster programmes have aimed at supporting R&D that strengthens industrial clusters by promoting co-operation in certain industrial fields, or around certain themes. The cluster programmes are administered by various sector ministries and were originally funded through the additional research appropriation programme between 1996 and 1999. The focus of cluster programmes has varied and has not always been technology centred.

There is great interest in innovation systems theory and the concept of clusters in the Research Council of Norway as well as in several ministries. This has led to the establishment of several instruments that are to encourage networking and the distribution of knowledge, competence and personnel in various parts of the innovation system. This applies to programmes like the NT-programme (The Innovation and Technology-programme for Northern Norway), Valuecreation 2010 and the MOBI programme.

The latter is an 'umbrella' programme administered by the Research Council of Norway. Its main goal is to promote learning, innovation and value creation in companies with little experience with R&D. In general this means SMEs. In many of these companies there are barriers to innovation, e.g. high risk associated with innovation activities, lack of relevant expertise and of knowledge on how to acquire such expertise, and lack of capital. MOBI's ambition is to reduce the number and impact of such barriers. The programme also aims at increasing the companies' R&D based innovation efforts by stimulating long term co-operation with other companies, R&D environments and actors from innovation policy institutions, particularly on a regional basis.

Commercialisation of research

Increased commercialisation of the results of publicly funded research is a central strategic goal to all governments in the Nordic countries. During the last two decades there have been a lot of efforts to promote commercial utilisation of research carried out at universities and other public research institutions. Currently intellectual property rights have emerged as a hot topic in all countries examined in this report. The situation in different countries will be described more extensively below.

A general trend seems to be that borders between universities, government research institutes and companies in knowledge production are becoming more blurred. Together with the changing institutional landscape, the activities of different actors are overlapping and encouraging the search for new mutual solutions in the organisation of knowledge production.

Intellectual property rights

Currently there are mounting pressures on universities and other research institutions to increase their efforts in the commercial utilisation of research results. Therefore, it comes as no surprise that for example intellectual property rights at universities and other research institutions has been a relevant topic in national policy discussions lately. Governments of the Nordic countries have assigned committees to consider ways of developing legislation concerning intellectual property rights. At the EU level an agreement to establish the European Patent Organisation was achieved in March 2003 and there is not yet information available concerning intellectual property rights. At the moment, Denmark, Finland and Sweden are members of the European Patent Organisation. Iceland will also become a member in the course of 2003.

At the moment Denmark has come furthest in this reform work.In January 2000 a new law on patents came into action making it possible for universities, research institutions and public hospitals to take over the rights of the inventions of their employees and negotiate terms of rights with companies. At the same time the institutions are obliged to further the commercial use of inventions. The establishment of new infrastructures at universities in support of the Act is believed to have considerable strategic significance in coming years. The performance of the present IPR system is currently under evaluation. The aim is to find out how the administration of patent applications can be improved and how the system can assist in an optimal diffusion and utilisation of new knowledge. A plan for the future IPR system will be presented in the spring of 2003.

Following Denmark, the other Nordic countries are also preparing changes in intellectual property rights legislation. In April 2002 the new Norwegian Government presented a proposal regarding changes in the law of intellectual property rights to Parliament. In its proposal the Government argued that universities and colleges should be more involved in the commercialisation of R&D results, especially in the form of patents, so that society gets more out of its investments.

The law is to be changed so that universities and colleges may claim the right to exploit commercially the inventions made by teachers and researchers. However, in order to secure the researchers' right to diffuse their knowledge, teachers and scientific personnel will have the right to publish their findings, even if this may stop the institution from commercialising the invention. According to the Norwegian government proposal the researchers are however obliged to inform the institution if they believe they have made an invention that can be patented. In order to stop the institution from taking over the intellectual property right, the researcher must make use of his or her right to publish the results within one year after the institution was informed.

Current Swedish patent law allows researchers at universities to keep the ownership of patents. This constitutes an exception from the general regulation of patents based on ideas developed by employees. This feature has been under debate for some years for several reasons. The case for passing ownership rights to higher education institutions is based on the argument that this would give universities an incentive to become more active in promoting commercialisation of research results, and that universities as organisations are better equipped than individual professors to look after intellectual property rights.

Those advocating keeping ownership with individual researchers have noted that there is a potential conflict of interest between academic freedom of communication and economic efficiency. Here they argue first that professors should not be coerced into secrecy agreements etc. against their will, and in the case where a researcher chooses to commercialise results, the university should be able to monitor that he or she keeps a proper balance between academic values and economic efficiency, rather than the university being involved as a party in any transaction. The issue of patent ownership in higher education institutions was raised in the Government Research Bill of September 2000. The current position of the Government is to await evaluations of the Danish experience before making changes in Swedish IPR legislation.

In Finland a committee set up by the Ministry of Trade and Industry together with the Ministry of Education has examined questions regarding IPR and the new emerging so called “third mission” of universities. In May 2002, the committee proposed the reversal of the Act of Employees Rights and a reform of the University Act. According to the new proposal, the researcher and teacher exception rule should be reversed – i.e. university researchers should be in the same position as any employee. If this rule comes into operation, universities could take over the rights for inventions in joint projects carried out in collaboration between themselves and a third party. The new act would not , though, cover the intellectual property rights in free academic research, where the inventor has the right to decide the primacy of publishing and utilisation of his/her invention. However, the act would be contractual: The regulations would be applied if not contracted otherwise by the parties involved.

The committee proposal also includes a clarification of the legal issues that would enhance the overall framework for innovative activities and their establishment as a third basic mission of the universities along with education and basic research. In the proposal, the utilisation of research results is included in the functions of the universities.

In promoting the commercialisation of academic research, increased coherence and networking between the relevant intermediary organisations - Tekes, Sitra and the Academy of Finland - has been identified as an area for further development. The planning and costs of commercialisation should be integrated with research projects. In parallel with the reform of IPR legislation, competencies about IPR issues should also be strengthened among university administration and staff.

Supporting services for commercialisation

During the last 10 years, there has in the Nordic countries been established supporting structures which assist researchers in intellectual property right questions, as well as in the patenting and licensing processes. Many of the services are located either at the universities or other research organisations, or at science parks.

In Sweden, supporting services for commercialisation of research are offered for example by the University Holding Companies and the Foundations for Technology Transfer. Between 1994 and 1995 eleven University Holding Companies (Holdingbolag) were established in the country. Their mission is to form project companies in order to exploit research from the universities and to develop services for such exploitation.

They are themselves owned by the universities and are expected to become minority owners in firms created jointly with researchers and industrial actors for the exploitation of university research. The Foundations for Technology Transfer in co-operation with the Holding Companies have, in turn, formed Patent & Licensing Offices (Forskarpatent*),* which actively support researchers' exploitation efforts. The formation of institutions like the Foundations for Technology Transfer and the University Holding Companies as well as the Patent & Exploitation Offices is a concrete manifestation of the political system's belief in the commercial potential of licensing academic research.

Besides the newly founded services, the national patent and registration offices are an established element in the innovation supporting structures of the Nordic countries. The Swedish Patent and Registration Office, PRV, grants patents and registers trademarks, industrial designs and names. It also registers limited companies and other forms of companies that need registration. The office issues authorisation to publish periodicals, and offers a number of commission services and training courses. The more comprehensive activities performed by PRV have to be financed fully by the users/clients. Similar tasks are carried out by The Norwegian Patent Office, NPO, which offers protection for inventions, trademarks and designs as well as information services, guidance and training in the area of industrial property rights.

Entrepreneurs and SMEs in national innovation policies

Entrepreneurs and small and medium sized companies are alongside universities at the centre of R&D and innovation policies both nationally and on the European Union level. Policy makers have strong expectations of new technology based firms in particular. There are several qualitative factors which make technology based start-ups and SMEs a vanguard of "knowledge and innovation based societies" in the global economy. The SMEs' contribution to economic growth is just one reason. Perhaps even more important is the fact that SMEs are supposed to be more flexible and innovative, less bureaucratic, and quicker to take advantage of new opportunities than larger organisations.

In some countries the national industrial structure is a natural explanation for the policy makers' interest in SMEs. Denmark, Iceland and Norway are all countries where the industrial structure is characterised by a large number of small and medium sized companies. In Sweden and also in Finland large parts of industry have been concentrated around larger companies targeting international markets.

In perspective, emphasis on SMEs and entrepreneurs is not a totally novel phenomenon. For decades the general orientation of industrial policies in many countries has been geared towards large enterprises, but from the 1970s onwards new start-ups and SMEs have been an object of increasing attention. Policies and measures emphasising small enterprises and entrepreneurs have significantly supplemented the industrial policy portfolios. The potential role of SMEs in economic growth and renewal of industries was referred to in policy documents of the late 1970s and the 1980s. A Norwegian White Paper on SMEs was published in 1978. Around the same time the Swedish Government was looking at start-ups and their growth potential with a growing interest. The Swedish Industrial Development Fund was created in 1979 with the objective to encourage profitable growth and innovation in SMEs.

During the following decade policies and measures were designed in Nordic countries to support especially research- and technology-based new firms and inventors willing to start their own businesses. The creation of new schemes and organisations for technology transfer, knowledge diffusion and commercialisation in the 1980s was a clear expression of the popularity of this policy approach. The technology parks, established in the vicinity of universities, were targeting new spin-off companies through incubators and spin-off services. At the same time more intentional policy moves were made in order to increase public and private venture capital operations.

Since the early 1990s the number of policy initiatives explicitly geared towards the needs of SMEs and start-ups has become manifold. Today the Nordic countries have several innovation policy measures which are aiming at supporting entrepreneurs, small and medium sized firms and start-upsin their endeavour develop their businesses and products and to promote networking with other companies, universities and research institutions.

The TUFF programme (Technology Transfer for SMEs) was created in Sweden to promote trade in technology services between public R&D technology providers and SMEs. The Finnish Technology Clinic initiative strives for the same goal. In the late 1990s several Business Innovation Centres and Industrial Development Centres were set up in Denmark to stimulate development processes and competence and product development in technology-oriented SMEs, and to promote entrepreneurship education in schools.

An Icelandic example is the Northern Coast Innovation Centre (NCIC), which was established in 2001. Among the activities of NCIC is the recruitment of a team of experienced executives which is to spread experience in the region and sit in the boards of new companies or projects.

An area growing rapidly during the 90s was venture capital market specialisation, especially financing of technology based start-ups and fast growing SMEs. In this situation different countries found it advisable to develop new policies in order to make it easier for start-up companies and technology based small firms to tap the growing private and public venture capital markets.

Today the number of measures aiming to link new technology based firms and venture capital providers are plentiful. Swedish Invest Forum CapTec is an annual investment forum for young technology-based firms and venture capital companies. Also public organisations with venture capital operations, such as Sitra or Industry Investment Ltd in Finland, were mandated to make equity investments in SMEs as a way to support growth. The Finnish public venture capital organisations could be called “funds of funds”. They have funnelled their investments in regional, branch or growth-funds and in this way stimulated the growth of private venture capital markets.

When we are talking about SMEs it is important to remember that the majority of smaller firms do not actively engage in any large-scale R&D activities. This is partly explained by sector-specific characteristics.

For example, in many traditional and/mature sectors research and development work has been a minor factor in the improvement of companies’ competitive position in the markets. Another reason is the lack of resources and competences needed to carry out R&D projects. If policies targeting SMEs are to overcome these obstacles it is essential that small firms are supported to upgrade their competence base. Otherwise a large amount of the small and medium sized enterprises will not be able to extract and apply new technologies and knowledge developed by other actors (companies, universities, research institutions etc.). In practice, it would mean that a major part of companies would be left outside the research and knowledge-based innovation systems or clusters.

Integrating innovation into regional policies

The future of more peripheral areas is causing concern in Finland, Iceland, Norway and Sweden. The reasons for this concern are among others the threat of depopulation of rural areas and increasing discrepancies in regional development. Recent development trends and research findings hint that dynamic positive trends of growth tend to concentrate nationally only in a few (and usually the largest) city regions whereas the rest of the country is lagging behind in relative terms. The situation is somewhat different in Denmark, which not only differs from the other Nordic countries in geographical terms but also has been ranked high in international comparisons when it comes to the degree of regional balance.

It is not, however, only because of the above mentioned challenges that policy-makers are currently paying more attention to regions. Geographical proximity matters also from an innovation theory viewpoint, as Kenneth Arrow pointed out already in 1962.[15]Innovation usually takes place within the framework of complex processes as a result of a variety of participants learning from and interacting with one another. Experience and research show that the innovation system's capacity for producing this type of results is a decisive factor in promoting growth. Geographic proximity has the potential to create competitive advantages in terms of interaction, learning, access to skills and cooperation in development and business. Regions that have recognised this can consciously develop their own competitive advantages.

Integration of innovation and regional development brings to the forefront the regional impact of universities and other public R&D institutions. In addition to inter-firm co-operation, entrepreneurship and new technology, the importance of higher educational institutions, like universities and other research institutions, for regional growth has been recognised in numerous studies. An example of this is the recent Finnish debate, in which the regional impact of universities and other higher education institutes is gaining more attention. The regional aspects of higher education have been discussed thoroughly by policy makers and the Ministry of Education has drawn up an action plan for the regional development of higher education up to 2006. Special emphasis has been given to connecting the development to the economic and industrial structure in the region.

Besides the significance of local knowledge producing institutions, the current approach to regional development emphasises the importance of local strengths and initiative. It is widely agreed that public measures supporting regional development should be built

[15] Arrow Kenneth (1962) ‘Economic Welfare and the Allocation of Resources for Invention,’ in R. Nelson (ed.), The Rate and Direction of Inventive Activity. Princeton University Press.

upon these factors. The approach is reflected in the Danish Government's strategy for regional growth, which was under preparation in 2002. The Government aims to further conditions for growth within trade and industry where the individual regions have specific competences. Co-operation between local and regional educational institutions, research parks and trade and industry has a special role in this plan.

The means are allocated through the Danish Regional Growth Centres scheme, which provides the opportunity for the individual regions to develop framework conditions tailored to trade areas and technologies in which the regions are specialized and have expertise. Also, the Jutlandic-Funen IT-Programme (IT boost for Jutland and Funen) is based on existing local strengths: The programme, on-going between 2002 and 2005, aims at developing partnerships between research and trade in the expertise areas of information technologies in which the local universities have specific competences. The programme is co-financed by the central Government and local authorities.

Similar kinds of policy approaches stressing the importance of local strengths are applied in Norway. The Ministry of Local Government and Regional Affairs is actively involved in the development of policy instruments promoting regional innovation activities. Examples include such schemes as MOBI and FORNY and the development of local incubators.

SND, the public agency funding industrial and regional development, is also supporting innovation activities at the regional level. SND has launched the ARENA programme - previously known as the Regional Innovation Pilot initiative - which aims to stimulate the development of regional innovation systems and industrial clusters. The programme is based on the idea that regional conditions are of great importance to innovation and value creation. By promoting regional co-operation between companies, R&D environments and innovation policy institutions, the programme is to contribute to increased growth and international competitiveness at firm level. The programme will generate R&D projects and establish both new arenas for – and new forms of – regional co-operation. The programme emphasises communication and inter-active learning between the involved parties, and wishes to contribute to the development of innovation policy instruments.

In Sweden regional growth agreements have been the principal tool for the implementation of the new regional industrial policy. The Swedish Government initiated a process for the development of regional growth agreements in 1997, and according to the statement of the Government, the agreements were to become the key instrument for co-ordinating and adjusting the policies of the various sectors, and also for exploring new approaches to the promotion of regional and local industrial development. The first regional growth agreements were launched in March 2000, when the first generation of such agreements were signed between 21 regions and the Swedish Government.

Measures pertaining to innovation policy are major components in the Swedish regions' growth strategies. To a substantial degree they focus on R&D activities, technology diffusion institutions and venture capital markets. These regional growth strategies are in general geared towards the specific industrial specialisations of the regions. Furthermore, VINNOVA has launched a new programme, VINNVÄXT, the objective of which is to promote the development of dynamic regional innovation systems allowing regions to be internationally competitive within selected technology and business areas. The key idea of the programme is to promote effective co-operation between companies, research and development organisations and the political system within regions. A limited number of regions (5-10) will receive financing during a ten year period, but will be evaluated regularly.

The Swedish Government has also established a new national programme for the development of innovation systems and clusters, which is in operation in the period 2002-2004. The aim is to strengthen and complement already ongoing activities at regional level to strengthen the regional competitiveness. The responsibility for implementing the programme will be shared by VINNOVA, NUTEK and the Invest in Sweden Agency, ISA.

In Finland innovation and regional policy issues are integrated in the national Centre of Expertise Programme, which attempts to promote the development of regions through promotion of R&D, innovation and networking. The first programme period covered the years 1994-1998. The second period of the programme started in 1999 and runs until 2006. The programme aims to enhance regional competitiveness and increase the number of high-tech products, companies and jobs. To achieve this goal, the programme will be used to implement projects that reflect the needs of industry, encourage co-operation between the industry, research and training sectors, ensure the rapid transfer of the latest knowledge and know-how to companies and exploit local creativity and innovation. Since the beginning of 2003 there are altogether 19 regional Centres of Expertise and three nationwide networks.

Decentralisation of decision-making power

In the recent past, regional actors have become increasingly important players in research and innovation policies. In many countries there is political willingness to devolve more decision-making power to the regional level. The Norwegian Government has considered means to strengthen the role of the counties in the development of innovation policy measures. According to the Government's plan the counties will be given larger responsibility for the development of local industry and as regards the implementation of innovation policy instruments and funding of innovation activities.

Some earlier changes in Norwegian policies concerning regional development were summed up in a White Paper on regional policies published by the previous Labour Government in the spring of 2001. It was stated in the paper that there will be a shift as regards focus, organisation and measures: From municipalities to regions, from individual measures to more coherent needs, from individual companies to a common effort for regional development, from sector oriented measures to co-ordinated efforts, and from centralised regulations to more regional freedom. An especially strong emphasis in the White Paper was put upon the use of public R&D and innovation instruments and funding in order to strengthen industry, employment and the size of the population in regions and non-urban areas. This is in line with the main regional policy objective of Norway, which is to secure a balanced development as regards population settlements and industrial growth.

In Sweden the Government presented a bill on regional development in September 2001, which points to a need to set up new municipal co-operation bodies. Focus of the regional policy bill “A Policy for Growth and Viability throughout Sweden” was the establishment of a new policy area - regional development policy. The purpose is to establish a well co-ordinated policy for all parts of the country, i.e. to create regions with well-functioning and sustainable local labour markets and with good services.

The Government argued for the need of pro-active strategies to reach this objective – including efforts within areas where investments are of great importance for regional development – and a clear division of responsibility between the Government and the municipalities. The latter means that municipal co-operation bodies should be established in all counties from the year 2003. These bodies will have the authority to make decisions about county plans for regional infrastructure and authority to decide about some governmental funds for regional development. One task of these bodies is to create programs for the development of the county – regional growth programs. The regional growth agreements will develop into regional growth programmes in 2004.

The need for institutional reform in the implementation of Swedish regional policy and the further development of the institutional setting and the process concerning Regional Growth Agreements was also pointed out by a parliamentary commission in September 2000. The commission suggested among other things that strategic discussions concerning the long-term orientation and specialisation of university colleges should be included in the further development of the regional growth agreement process.

In Finland a step towards devolution of decision-making power to the regional level was taken in 1994, when the Regional Development Act came into force. The main purpose of this Act was to guide the national regional policy. The Regional Development Act had significant effects on the structures of regional development and governance. The Act increased the importance of local government in regional policy by delegating power from the central Government to the regions. Another key effect was the establishment of regional governance on an economic-functional basis. Moreover, a programme-based regional policy was introduced in order to co-ordinate the actions of diverse regional organisations and actors.

Another institutional reform in Finland, which concerned regional level administrative structures and the empowering of regional bodies, related to the establishment of new regional employment and economic development centres in 1996. The new centres were composed by merging the former regional offices of the Ministry of Trade and Industry, the Ministry of Labour and the Ministry of Forestry and Agriculture.

Nowadays also experts of the regional networks of Tekes and the Foundation for Finnish Inventions can be found under the same roof of the TE-Centres. The Employment and Economic Development Centres have a significant role in the implementation and administration of EU structural funds in areas eligible for EU-funding. A centre contributes to the development of its region by financing its client companies' investment and development projects and, more generally, projects aimed at enhancing their operational framework and the rate of employment within the private sector.

A fresh input consists in regional technology strategy processes, which were carried out by local actors in several regions in Finland in 2001-2002. Regional technology strategies are intended to be continuous processes, not time-limited projects. The first round of strategy processes was implemented concurrently with the updating of the national technology strategy, which was led by Tekes. The leading idea behind the regional strategy work is to initiate an open and critical discussion between regional actors about how to employ technology in regional development in co-operation with industry and actors responsible for regional development. The aim is to find a common view about the technologies to which investment should be directed regionally. The identification of local and regional strengths is in that sense of outmost importance for successful strategy processes.

Challenges in creation of regional innovation policies

In general, a more active role of regions in innovation related decision making is a natural direction of development, a local strengths and development needs are supposedly better known at the regional level. At the same time, though, devolution of power brings about new questions. Various evaluations and studies analysing impacts of regional initiatives and programmes have shown that there are still many obstacles to the strengthening of regional innovation policies.

Usually initiatives have succeeded in enhancing the awareness of positive effects of R&D and innovation activities for regional competitiveness. Increased co-operation and co-ordination between regional actors have also been recorded in the studies. All this has had positive impacts on regional development, which has become more systematic. Problems remain, however, in relation to the co-ordination of regional activities at the national level and between regions. There are often a number of organisations involved in the implementation of initiatives and the distribution of duties is not always unambiguous or clear. Insufficient co-ordination of activities between administrative sectors at the national level has turned out as one of the weaknesses.

Without co-ordination there is a danger of duplication of activities and inefficient use of scarce resources. The consequence can be fragmentation so that critical mass cannot be acquired by anyone. In the case of small countries like the Nordic ones this threat is always around the corner. In terms of population, the regions of the Nordic countries are in an international comparison very small. Therefore, it is of utmost importance that regional activities in the field of research and innovation are based on clear strategies and are concerted both on the national and regional level.

So far, there are in the Nordic countries no such formal arrangements with the task of co-ordinating regional efforts with those taken either national level or by other regions. Instead, a recent benchmarking study pointed out that there tend to be a “division of labour” between regional and national actors with respect to the areas they are focusing on. Regions' efforts focus more on innovation in SMEs, technology transfer and cluster development, whereas responsibility for the issues of research policy is typically left to the national actors.

Last but not least, the general discussion about regions' role in innovation easily clouds the fact that regions differ substantially from country to country in relation to the level of authority, scope of action and resources. This becomes clear if we compare sparsely populated regions of the Nordic countries with the situation in Central-Europe. With regards to the level of authority, we can in the one end of the spectre observe the German *Länder* with their own fiscal authority and large responsibility for education, research and innovation, and in the other end find many Nordic regions which are often administrative rather than functional entities, i.e. regional extensions of national administration with limited authority and resources.

Cross-border co-operation

Cross-border co-operation between neighbouring countries at the regional level is an emerging trend, which relates also to innovation policies. The best known example in Northern Europe is undoubtedly the co-operation within the Öresund region, which includes Eastern Denmark and southern parts of Sweden. A strengthening of this co-operation is on the regional policy agenda of the Danish and the Swedish governments. The Danish Ministry of Science, Technology and Innovation and VINNOVA of Sweden are responsible for the Öresundskontrakt initiative, which promotes common R&D projects between companies, universities and research institutions from both sides of the Öresund strait. Northern Sweden and Northern Finland comprises another area where cross-border co-operation in promotion of innovation activities is getting more importance.

The anticipated enlargement of the EU in May 2004 will create an interesting new situation, when all the countries around the Baltic Sea except the Russian Federation will be EU members. This development is expected to increase co-operation in the Baltic Sea region. Private businesses from Denmark, Finland and Sweden are already collaborating intensively with local actors and companies in the Baltic states and Poland. In the future, the potential for more developed regional co-operation between the Nordic countries and adjoining new EU members cannot be excluded.

An area of cross-border co-operation touches upon collaboration at the level of R&D programmes. VINNOVA in Sweden and Tekes in Finland are co-administering an on-going technology programme called EXSITE (Explorative System-Integrated Technologies). Participants are universities and research institutions and there is for each Swedish project a corresponding project in Finland. The programme is successor to the INWITE (Integrated Technologies Wireless Telecommunication) programme, which was financed jointly by Finnish and Swedish agencies and companies. The main objective of the INWITE programme was to enhance the long-term competitiveness of the Swedish and Finnish companies within the telecom sector. The programme provided a framework for sharing resources in pre-competitive projects that are needed to explore the possibilities of future technologies.

Conclusions

The Nordic countries have many features in common. In spite of similarities on the surface level there are, however, many distinctive features concerning industrial structures, organisation and priorities of research and innovation activities. Large export oriented firms have historically played an important role in Finland and Sweden. A small number of the largest companies in Finland and Sweden also stands for an important share of total research and development expenditures. Denmark, Iceland and Norway each has an economy which is characterised by small and medium sized companies. In other respects, the industrial structures of these three countries differ from each other. Denmark has been successful in nurturing a vivid SME sector, which covers firms from more traditional as well as newer industries. In Norway and Iceland the economy is based more on industries utilising opportunities offered by natural resources – in Iceland's case fishery and in Norway's oil and gas industries.

Arrangements for the co-ordination of innovation policy making between sector ministries as well as between ministries and intermediate agencies dealing with innovation policy issues vary from country to country. For example, Finland and Iceland have opted for an advisory body system working at the highest possible level. The Science and Technology Policy Council led by the Prime Minister bears responsibility for the direction of science, technology and innovation policy.

Today all the Nordic countries are looking for institutional arrangements which can help to achieve a more integrated approach in research and innovation policy making. Traditional administrative boundaries between sectors dealing with research financing, industry oriented R&D or innovation funding or more general business development needs are increasingly seen as problematic and unsuitable for a more comprehensive approach to innovation policy. This quest for new solutions has lately led to significant reforms in innovation policy structures in all the Nordic countries except perhaps in Finland, where the institutional restructuring process has been more incremental.

So far, the most radical reform concerning innovation policy making and institutional structures has been implemented in Denmark. At the policy-making level the most important change was the establishment of the new Danish Ministry of Science, Technology and Innovation. In addition, an extensive reform of the public research system as a whole is under its way, having impact both on intermediaries (research funding agencies etc.) and research performers including universities and the research institute sector.

Sweden has also implemented a substantial reorganisation of the structures for public funding of research and technology development and support to business and regional development during the last couple of years. The reorganisation involved some 15 organisations, but after the reform the number of organisations was reduced to six. The new structure is to enable more focused public efforts in areas of strategic importance, greater efficiency, and a better adaptation to the needs of target groups. On the research and R&D funding side the new Swedish Research Council was established. Another feature of the new funding structure is VINNOVA (the Swedish Agency for Innovation Systems). Significant changes are taking place also in Norway, where a new holistic national innovation policy is under development. As part of the process the Norwegian Government has decided to implement an institutional reform among public organisations supporting business and regional development. Public measures supporting innovation and internationalisation will be gathered together within a single organisation.

When reforming national innovation policies transnational policy learning is potentially a significant source for new ideas and policy design. In general, it seems that the awareness of the need to monitor and learn from other countries is high among Nordic innovation policy makers. However, the constraints for policy learning between countries are many and the lack of time is not the smallest one.

Over time innovation policy priorities in the Nordic countries have had their peculiar national features. At the more general level it is however possible to identify certain trends which are common for the Nordic countries. For instance, in the 1980's the policy of large national research programmes targeting strategic areas were a common phenomenon - as was the case in many OECD countries. At the turn of the 1990s the Nordic countries went through a deep economic recession which intensified the search for new priorities in national policies. Industrial policies were redefined in different countries, and in this context, national needs for activities that are internationally competitive also in the longer run were placed at the centre of policy efforts.. This meant a shift in focus from 'old' businesses towards new emerging technologies and business areas.

It was in the early 1990s that systemic thinking in research and industrial policies gradually started to gain ground in the Nordic countries. Finland was among the first to adopt terms like “national innovation system” and “cluster policies” into the national policy design to a substantial extent, and the country later became a benchmark country in relation to the utilisation of a systemic perspective in research and innovation policy design. Overall, the 1990s constituted a period when there in many countries was a quest for a more systemic approach in the development of policies related to science, technology and industrial development. In Norway and Denmark, just as in Sweden and a bit later in Iceland, the real breakthrough of innovation systems thinking at the policy-making level took place in the latter half of the 1990s.

International research and R&D collaboration is one area which has gotten increased attention in the Nordic countries during the last few decades. This development is partly explained by the fact that international interaction and collaboration is an essential issue for small countries like the Nordic ones. Rapid and even drastic changes in the wider international environment and economic system have promoted this approach. In the field of research and innovation policy global and European developments have opened up new horizons, increased cross-border networking and enabled the pooling of resources for common goals. The European Union research programmes and structural programmes are today important measures complementing national policies.

Elements of national innovation policies

Research and innovation funding has developed differently in the Nordic countries within the last 10 years or so. In the 1990s financing increased particularly rapidly in Finland and Sweden. A major part of this growth was explained by increasing R&D expenditures in private companies, and especially in some large companies such as Ericsson and Nokia, which were operating in the booming ICT and telecommunications sectors. However, also public funding of R&D was increased quite substantially in both countries, in Sweden in the early 1990s and in Finland in the late 90s.

In the other Nordic countries trends in the funding of research and innovation were more modest. Denmark and Iceland have had quite stable increases over the last 10 years, whereas in Norway's case, the share of R&D funding to GDP has stayed more on the same level. At the turn of the century the need to allocate more public resources towards R&D has re-emerged on Norwegian policy agenda.

Since the beginning of 1990s the promotion of private funding of research and innovation activities has become a policy issue in Nordic countries. Recently Denmark and Norway have adopted tax deduction schemes in order to promote R&D in companies. Besides the tax deductions for R&D there are nowadays tax schemes which aim to alleviate employers' problems with recruiting key staff members from abroad. These kinds of schemes are in operation for example in Denmark, Finland and Sweden.

Still another tax related solution is presently tested by the Icelandic Government, which made a decision to lower the general corporate income tax from 30% to 18%. This decision, which came in effect in 2002, is supposed to have a positive effect on firms' willingness to invest in technology based industrial projects and even in R&D activities. Besides the tax schemes the Nordic countries have designed initiatives which aim to promote the development of viable venture capital markets. Governments increasingly recognise that private investors, business angels and venture capital corporations have a key role to play in the near-to-market phase and commercialisation of innovations. The venture capital market is developed furthest in Sweden.

The extension and strengthening of networks of co-operation between innovation actors is today one of the main objectives of national innovation policies. Collaboration between actors is seen to stimulate the creation of new economically successful innovations. A number of innovation policy measures in the Nordic countries aim to increase connections between companies, research institutions, universities and other educational institutions. For instance, the public R&D programmes either at national or the EU level aim deliberately to strengthen the collaboration between firms and universities and research institutes. Promotion of networking is also an integral part of the public programmes and measures which focus on cluster development, regional development or both. Cluster or regional programmes can be found in all the Nordic countries.

Apart from networking, innovation policies and designed policy instruments in the Nordic countries are today promoting the commercialisation of results of publicly funded research, entrepreneurship and development of growth oriented small and medium sized companies as well as the birth of new technology based start ups.

During the last two decades there have been many of efforts to promote the commercial utilisation of research carried out at universities and other public research institutions. Currently intellectual property rights is a hot topic in all countries examined in this report and major legislative changes in relation of IPR questions have already taken place or will come into force shortly. The Nordic countries have also established support structures which assist researchers in intellectual property right questions as well as in the patenting and licensing processes. Many of the services are located either at the universities or other research organisations or at science parks.

Currently the role of universities and small and medium sized companies is receiving increased interest also in the context of regional development. Innovation and regional policies have been moving closer to each other in Finland, Iceland, Norway and Sweden. In these countries the future of more peripheral areas are causing concern. In this situation promotion and inducement of innovation activities at the regional level is seen as a cure against a gradual lagging behind in the regions in Finland, Iceland, Norway and Sweden.

Integration of innovation and regional development brings to the forefront the regional impact of firms, universities and other public R&D institutions. The current approach to regional development emphasises the importance of local strengths and initiative. It is widely agreed that public measures supporting regional development should be built on these factors. Overall, this attention paid to the regional dimension of innovation is leading to a situation where regional actors become increasingly important players in research and innovation policy making. At the moment there are in many countries also political willingness to devolve more decision-making power to the regional level.

Policy recommendations

Economic, social and political assumptions

Nordic countries are all small, open and high cost countries. That means that their economic welfare relies to high extent on import and export of products and services on international markets. In practice that means that it is important to take needs and demand very much in consideration when policies are formulated. It would be a mistake only to look on the problems from the supply side.

Recommendations regarding industrial learning

All the Nordic countries have now "on paper" accepted the systemic view of innovation, meaning that innovation is understood as the result of complex processes in networks of people, companies, organisations and regulatory frameworks. The main focus is on learning, i.e. the companies' ability to find, understand and make use of knowledge. The keyword is competence, not information, as information is of no value unless the innovators are able to understand and make use of this information in a practical setting.

Even if many politicians and policy makers express support for this complicated – but nevertheless common sense – view of innovation, in practical policy they often fall back to a more linear, old fashioned view of how innovation takes place. There is a tendency to promote research as the solution to all innovation problems, as if research can solve all the problems industry and society are facing. Moreover, there is also a tendency to use the words research and innovation interchangeably, as if these two concepts are synonymous.

Research and development is important, and there are many good arguments for increasing the R&D investments in at least some of the Nordic countries, but this promotion of research and development must be integrated into a broader policy that also takes into consideration other forms of innovation.

In other words the main objective must not be an isolated increase in national R&D expenditure, but the need for an innovative industrial sector that can contribute to the development of social welfare.

Many companies – especially in the so-called low-tech industries– do not innovate through investments in R&D, but by other means. They focus on incremental improvements in products and production techniques, they invest in branding, design and marketing and they make active use of new knowledge and new technologies developed elsewhere. The technology "developed elsewhere" may indeed be based on R&D, which is why a country's total investments in R&D is of importance, but encouraging these companies to do more research will not necessarily lead to more innovation.

It is possible to develop policy measures that stimulate the learning and innovation capabilities of these firms. These may be instruments that help companies organise their own activities in a more sensible way, instruments that encourage networking between firms and knowledge institutions or measures that stimulate mobility between firms and institutions. After all, the most valuable form of knowledge are the competences embedded in the individual.

There are actually quite a few policy measures of this kind in the Nordic countries, and in some areas Nordic countries have played a pioneer role in developing such instruments (cf. the use of the Norwegian BUNT model in other countries). Policy makers may learn from their neighbours in this respect. However, many of these measures are experimental with limited budgets.

There is a tendency in some of the countries to underestimate the need for competence and network building programs and instruments. Policy makers often tend to focus on the R&D input to the innovation process, neglecting the need to integrate this R&D in the learning processes in the firms and the process of bringing the new products, processes and services to the market.

Companies do not have access to perfect information. They are restricted by their own history, experience, contacts and educational background, and especially SMEs lack the resources needed to go on a systematic hunt for new competences. This leads to technological lock-in, i.e. a strong reliance on existing technologies and conventional ways of problem solving. This may work well as long as the competitors behave in the same way, but as soon as the challengers start innovating, the traditional companies will lag behind.

What may bring these companies over the threshold is help from outsiders that have the understanding of the innovation system needed to guide them in the right direction, to help them find potential private and public partners, and that can help them develop relevant competences. In this way society will get more out of all the investments made in education and research.

The civil servants working in research councils and innovation agencies often have the competences needed. They have developed an intimate knowledge of relevant industrial sectors and branches through their management of loans, guarantees and grants. They may have the bird's view of the innovation landscape the companies lack. Given the proper resources these civil servants may bring the companies in touch with relevant contractors, R&D partners, customers and knowledge institutions, thus making the completion of this innovation project possible.

It could be argued that the state should not be made responsible for company learning, that this is a part of the innovation process the companies should handle themselves, and if they are not able to do so they will have to make room for other companies that can. This is a valid argument, especially for large companies.

However, if the objective is to develop a broad based industrial sector (næringsliv in Scandinavian terms) that is flexible enough to meet unforeseeable changes in technologies and social and economic framework conditions, the Nordic governments must consider measures that help small and medium sized companies over the first hurdle. Moreover, this is probably the only way to make sure that investments made in education and research are used efficiently by industry. Lastly, it should be noted that most western countries have included learning and networking in their innovation policy instruments.

GoodNIP proposes that national authorities take a close look at their innovation policy instrument portfolio and see if the following functions are covered, either in separate programs or institutions or as part of others:

Measures aimed at improving the absorptive capacities of firms, i.e. their ability to organize their activities in search a way that the necessary learning takes place.
Measures aimed at broadening the activity base of the firms. During recessions companies have a tendency to focus on their core competences, and avoid investing in more risky – but potentially rewarding – projects. This means that these companies may harbour valuable ideas and competences that are not brought to life. The authorities may bring about the birth of these innovations by supplying high risk capital and by finding potential partners that may help bringing them to the market.

Measures targeting "unborn" industries or technologies. Current policy instruments are normally servicing existing types of firms and technologies, with programme boards manned by representatives of traditional industries. This makes it hard for newcomers to get the support they need. Policy makers should develop policy instruments that guide radical entrepreneurs to sources of finance, R&D institutions and commercial partners.
Measures aimed at improving the interaction between knowledge institutions and industry. In order to make the large public investments in education and research pay off, policy makers should look at alternative ways of facilitating knowledge transfer and co-operation. This applies to research institutes, universities and colleges as well as other educational institutions.

However, one should respect the unique qualities of the relevant types of institutions. The strength of the universities are their ability to focus on long term fundamental research, a type of research that cannot be supplied by small and medium sized enterprises. Hence it would be a grave mistake to turn the universities into servants of industry only. Moreover, universities and colleges are nor homogenous institutions; the industrial relevance of various institutes, disciplines and cultures will wary a lot, as will the research units' ability to co-operate with companies. In some areas one should aim at a close co-operation between university units and companies (especially as regards technologies close to the market), in others one should look at alternative ways of technology transfer.

All Nordic countries should implement a university and college IPR policy that encourages relevant researchers to patent and commercialise their inventions. Besides, assessment of the effects of the existing rules should be implemented.

All Nordic countries should develop policy measures that encourage interaction and co-operation between companies and relevant university and college units. However, this should not be made an overall objective relevant for all types of companies and university disciplines and units. Small companies will often not have the competence base and resources necessary to take part in this kind of co-operation, which means that other forms of technology transfer is needed. Moreover, the unique role of universities as havens for long term fundamental research must be protected.

General policy advice

When developing national innovation policies, the national governments must take the uniqueness of their own innovation systems into consideration and not blindly adapt strategies developed for other industrial structures and different political systems. Different types of institutions or companies may fulfil similar functions.

In Norway the large institute sector can function as a bridge between the university and college sector and industry. These are institutions that know the needs of companies and that are used to perform applied research and development. They do not to the same extent as university scientists perceive a conflict between commissioned and curiosity driven research.

Sweden, on the other hand, lacks a similar institute sector. This means that the universities and colleges must be given the role played by the institutes in Norway. This brings basic and applied research closer together, but it may also lead to cultural conflicts, as university researchers may find it harder to combine the need for industry relevance with academic performance.

The point here is that differences in innovation system structures may lead to the need for different policies. There are no “best practices”. Nor do the Nordic countries necessarily have to adapt strategies developed in larger European countries. This especially applies to regional policies. These are all small nation states, comparable to counties or *länder* in other countries. One cannot expect Finish or Icelandic counties to act in the same way as French *departements*.

Policy makers should also be careful not to put too much emphasis on statistical comparisons between countries. The fact that a country lags behind as regards one or two indicators does not necessarily mean that the innovation system is not functioning. It could be that deficiencies in one area are compensated by stronger performance in others.

For instance: The differences in Nordic R&D investments in R&D are significant, but they can partly be explained by dissimilarities in industrial structures and by the fact that countries like Finland and Sweden has been dominated by large R&D intensive corporations like Ericsson and Nokia. These companies have obviously functioned as industrial locomotives, meaning that their R&D efforts have benefited larger parts of the industrial sector. The fact that Norway, Denmark and Iceland lack such industrial giants does not mean, however, that these countries cannot develop innovative companies; they can and they do.

Today, it seems like innovation policies are like a soccer league, where each and every country struggle to reach the top of the Premier League, whether the points are measured as R&D as a proportion of GDP or entrepreneurial activity. One should keep in mind that all the Nordic countries are in the Premier League, meaning that they all are wealthy welfare states with strong economies, open markets and well developed knowledge bases. The main point cannot be to be the best in class as regards one or two indicators, but to develop a well functioning innovation system that can bring forth the innovative companies the economy needs to replenish itself.

GoodNIP will warn against innovation policy reductionism, meaning that innovation policy objectives are reduced to reaching a certain number on a particular investment scale. We appreciate the fact that policy makers need measurable goals to inspire politicians and others to make the investments that are necessary. It is hard to communicate the complex needs of an innovation system. Nevertheless, by focusing on one type of investment only, e.g. R&D investments, the policy can have unforeseen and unwanted consequences. Given that the majority of Nordic companies are small and in industries that do normally not invest much in R&D, an increase in national R&D investments will have to be the result of a change in industrial structure, i.e. one will need a large number of new R&D intensive companies.

This has been the strategy followed by Finland. ICT companies are R&D intensive companies, and by investing in ICT the Finns have been able to increase their R&D investments substantially. In the Finnish case, this was probably a very sensible approach to a difficult situation in the early 1990s. At that time the country was in severe economic crisis and had to find new ways towards prosperity. This does not necessarily mean that Iceland or Norway must develop an equally large ICT industry to replace the fisheries. The fisheries and the aquaculture industries are both innovative and profitable.

That all these countries need a competent ICT sector is another matter. All modern countries need ICT companies that can find, understand and adapt new technologies to local needs. This does not mean, however, that these companies should represent a new "wave" that is to replace traditional industries.

If a country decides to keep profitable industries with low R&D densities, the public sector must probably take a larger responsibility for the knowledge production in this area. Some of these branches of industry are dominated by very small enterprises that find it hard – or even impossible – to invest in R&D. That does not mean that these companies are not in need of R&D based innovation. They make use of advanced technologies that are based on R&D, and their ability to make use of these technologies rests on the innovation systems ability to absorb such technologies. Hence there is a need for university research and branch institutes that can contribute to the development and adaptation of new knowledge and new technologies for use in services and the low R&D-intensive industries.

A new holistic innovation policy

Sweden and Norway is in the process of developing new broad based or "holistic" innovation policies that take into account the effects of policy areas lying outside the core of traditional innovation policies.

Normally industrial innovation policies have been limited to ministries responsible for industrial development, the economy, regional development and R&D policies. Given the systemic nature of innovation, however, it is clear that policies developed elsewhere may have repercussions on the companies' ability to learn and innovate.

To give some examples:

The general tax level will influence the companies' ability to invest in innovation and R&D activities. The existence of a well developed physical infrastructure (roads, railways, airways, broadband) will determine the companies' ability to export goods to other areas and countries in a cost efficient way. The existence of a solid physical infrastructure also influences the companies' ability to recruit competent personnel. Do the employees have to move to this location, or can they commute? If they have to move, is there a cultural and social environment that makes it attractive for young families? Are there inexpensive kindergartens and good health care?

The point is not to make all policy areas servants of industrial development, but to encourage policy makers in these policy areas to take the needs of industry into consideration when developing new policies.

The GoodNIP team believes this is a sensible and much needed strategy. As it is well meant policies targeting innovation may be hampered due to other policy measures developed elsewhere. By developing new holistic innovation policies the Nordic governments may find new ways of using the countries' national and human resources in a more efficient manner.

However, such policy development is hard work. It is difficult to map and analyse the interaction between various policy areas, and it is difficult to explain such policies in a simple manner. Hence it is important that the national governments make the necessary investments in personnel, research and collaborative efforts.

2. Rationalities and innovation policy learning

By Per Koch, Johan Hauknes and Rannveig Røste, with contributions from Lennart Norgren, Juha Oksanen and Kasper Edwards. [16]

Innovation policy innovation

In the same way as there is a tendency to oversimplify industrial innovation processes, there is also a tendency to regard policy development as straightforward rational processes. They are not. Innovation policy is for instance not a simple transformation of innovation research into practical policy measures and institutional reform. The innovation processes taking place in the innovation policy system are just as complex as the ones found in industrial settings. There are intricate social rules, conflicting world views, intense power struggles, and uneven levels of competences and funding.

In spite of this, we seldom find innovation policy makers that have explicit strategies for policy learning and policy innovation – even if the same persons are acutely aware of the need for industrial innovation policies. This is a problem, for politics is about making things happen, and if the policy system stops you from implementing much needed reforms or hinders the learning processes of the policy makers you will end up with policy failure. The innovation policy system will not engender the kind of industrial innovation one is looking for, and society will not reach overall objectives for economic growth and welfare development.

It has not been the primary task of the GoodNIP project to study the social processes behind innovation policy development. Such an endeavour goes beyond what is possible within the time and resources allotted to this project. Based on previous research[17], analysis of policy documents and the participants' extensive knowledge of innovation policies in the Nordic countries, we have, however, been able to make a preliminary analysis of one important part of the social construction of innovation policies, namely the rationalities or "mental maps" of Nordic policy makers and the practice of policy learning. It should be noted that several of the GoodNIP researchers have a background from policy development in Nordic ministries and research and innovation policy agencies.

The role of rationalities

Innovation policies in the Nordic area have generally been characterized by a political consensus. The conflicts exist rather at ministerial level; between departments, between different groups and organizations in the ministries and between the different ministries and agencies.

These struggles are to a large extent a reflection of conflicts of interest and fights for power, prestige and funding. However, if this was all there was to it, one could at least presume that the contestants shared a common view of reality, which would – in principle – make communication less complicated. If you took away the tactics and saw through the rhetoric, it should be easy to establish a common ground for learning.

[16] Parts of this paper will also be published as a separate STEP report.
[17] Koch, Per M. & Hauknes, Johan (2000)

Although some participants may pretend – or even believe – that this is the case, the reality is much more complicated. The conflicts are actually often based on different concepts of reality – i.e. different mental structures or "rationalities".

By rationalities we understand a relatively long lasting understanding of the reality shared by members of a culturally and socially defined group. They may be interpreted as "genres", "paradigms" or as ideal models of industry. Rationalities persist, or have inertia. They continue to operate after the period during which they originated and are embedded in institutional structures and arrangements as well as in policy practices and instruments. The rationalities are generally unspoken – they are not explicitly formulated in policy processes – but are visible in the construction of concepts and attitudes.

For the individual rationality constitutes a mental map of concepts and beliefs in a specific area. A rationality can be compared to his or hers "life word" if we use a term from hermeneutical philosophy.[18] A "life world" is the sum of the individual's personal experiences, his or hers education and cultural environment. In this context an innovation policy rationality is a part of this "life world". Hence an individual may have rationalities that delimits his or hers idea of what constitutes industrial innovation, learning, or – to use a completely different example – love. There are no clear boundaries between such "sub-rationalities", as what a person believes in one area of life will influence his or hers believes in others.

A person is not a separate atom. His or her life world and rationalities is shaped in a cultural and historical context, shared by others. Hence, although each person represents a unique combination of experiences and beliefs, he or she will be part of various social groups that share rationalities.

Moreover, the person will take part in the overall rationality of this particular epoch or *mentality*, a "super-rationality" which is partly based on living beliefs, philosophies, ethics, religious beliefs, myths and legends. According to philosophers like Hans Blumenberg this common heritage will result in one particular problem becoming the main focus of a specific culture and era (cf. the idea of epochs found in other historians of science and mentalities, including Foucault and Kuhn).[19]

Rationalities are required for any kind of thinking. People need such "*pre*-judices", i.e. the ability to approach a phenomenon or problem with certain predisposed ideas of what this is, in order to understand anything. However, such rationalities also set limits to what it is possible to believe and conceptualise.

There are no absolute and clear borders between various rationalities in a social setting. However, people tend to drift towards social groups that share their own view of the world. Moreover, if they do not share this view in the beginning, they may soon be "socialized" or "encultured" into the same context. This is one reason why parties or workplace departments often is populated by people who share the same view of reality.

[18] Ricoeur 1974; Heidegger 1977; Gadamer 1989
[19] Blumenberg 1983; Foucault 1972; Kuhn 1962

A written ideology or philosophy – i.e. a systematic and codified rendering of the nature of reality – may be based on one or more rationalities, it can even be an attempt to conceptualise a rationality. However, there is not necessarily a one to one correlation between rationalities and specific ideologies or theoretical schools. We have all seen how old ideologies live on in rhetoric and social institutions, although contemporaries neither share nor understand these beliefs. Moreover, policy makers and others may make use of ideologies they themselves do not believe in, in order to gain influence.

Political parties and organizations may base their policy development on a clear ideological basis, for example classical political ideologies like liberalism and socialism. However, in some countries policy conflicts do not follow the dichotomy of political ideologies or party lines. Instead the conflict may be defined by other forms of ideologies, or one may find that different rationalities are present in the same political party or that one rationality is found in more than one political group. This is becoming more evident in a post-modern world where the old dividing lines between socialism, liberalism and conservatism are becoming blurred.

In the Nordic countries innovation policy development is based on several conflicting rationalities. The dominance of one or more rationality may vary from country to country, as may the "rationality mix". However, in the context of the GoodNIP project we have mapped a few dominant innovation policy rationalities.

There is one rationality based on traditional economics, characterized by a belief in a balanced economy plagued by market failure. There is another rationality based on a systemic view of innovation, where the main focus is on networking and the learning capabilities of firms. Then there is a rationality based on a strong belief in the importance of university research and basic science, one focused on entrepreneurship, and – finally – one "planning rationality", which presupposed the possibility of far reaching public planning. The rationalities will be described in detail below.

These various rationalities are found in many parties. Still, when one studies the conflict between the various ministry departments, one soon find that some rationalities dominate some departments and not others, regardless of the political affiliation of the relevant minister. In this context it is therefore more interesting to study how *rationalities* rather than political ideologies construct innovation policy.

It is impossible to give a clear cut definition of what constitutes a particular rationality, partly because it is shared by many people, who all have developed their personal variant of this or that particular belief system, and partly because the rationalities are not explicitly formulated in comprehensive theories of what this or that particular phenomenon is about.

However, as soon as a policy maker starts fighting for the interests of his or her institution or policy area, he or she will make use of theories and "facts" in order to convince others. Hence, if there is a conflict involving different rationalities or ideas of how the world really works, the parties involved will have to try to conceptualise their ideas. They often do this by making use of already existing ideologies or theories.

In many European countries one will for instance find that policy makers make use of arguments from neoclassical economic theory and evolutional systemic innovation theory when arguing for a particular standpoint (e.g. on the topic of active public intervention in enterprise innovation processes).

By mapping these arguments one may gain a certain impression of the rationalities behind this use of ideologies and theories. However, one must be very careful when doing so. Policy makers may make use of theories they actually do not believe in, in order to convince an opponent that is entrenched in a conflicting rationality. Moreover, policy makers may have a weak understanding of the total implication of a specific theory or ideology. Hence there may not be a one to one relationship between the political rhetoric based on these ideologies or theories and the policy maker's true beliefs.

Rationalities from sociological and organisational points of view

When interpreting rationalities at group level, one may understand the relation between individuals and the social world as Berger and Luckmann[20] understands it: as a continuously dialectic condition between individual human beings and the relevant social systems. Acts that are often repeated in a social situation become institutionalised; they fit into a pattern that can be reproduced without particularly efforts.

The human beings taking part in these institutionalised systems read these as the objective reality of society, partly because these systems have a history starting before the individuals' own life and partly because the individual will find it hard, if not impossible, to change the institutionalisation.

National innovation policies develop across several national, local and international political and bureaucratic units. These units lay down the framework and establish the policy instruments that have an impact on innovation activity. There are, however, seldom one single unit at local, national or international level that develop innovation policy alone. There are rather a lot of organizations and institutions that can have an impact on how the national innovation policy develops and changes over time. According to theories following the rational organisation perspective, a study of political and bureaucratic units, and how they change over time, will give a clearer picture of how national innovation policies are shaped.[21].

Organisations are units with highly formalized social structures, aimed at relatively specific goals. These formalized social structures define the coordination and specialisation of work that must be accomplished by the members in the organisation. These are highly specialized roles, independent of the members' personal and social characteristic. What is produced in an organisation may therefore be quite predictable.

However, the formal structures can never succeed in capturing the "non-rational" dimensions of organisational behaviour. Organisations are, first and foremost,

[20] 1966
[21] Scott 1992

collectives. Phillip Selznick[22] viewed organizational structure as an adaptive organism shaped in reaction to the characteristic and commitments of the participants, and by influences from the external environment. The organisational system develops means of self-defence. Self-maintenance becomes often the superior goal.

Selznick's research is often categorized under the institutional organizational perspective.[23] Theories in this area are based on the idea that the formalized structure of the organisation cannot overcome the "irrational" human factor in the organisation's behaviour. The individuals have complex needs and interests that are not defined in the formalized structure.

What happens is that the formalized structure in the organisation undergoes a process of adjustment based on the actual behaviour that take place in the organisation, and that this behaviour gradually institutionalises into roots and routines for organisational behaviour.

According to this thinking social systems have a limited resonance towards the surroundings, as they mostly reproduce themselves without absorbing views from outside their own system.[24] The surroundings are selectively perceived by means of the system's own categories and criteria for what is relevant. Given this organisational "conservatism", one may wonder what it is that leads to new understanding in a particular policy area.

According to the actor network approach[25] the study of society, and of innovation, must be based on the identification and understanding of "actor-networks", how they come into being and how they persist. Actor-networks are constructions of individuals, institutions and technology that come into being through tactical operations where one or more actor or groups try to convince others that their understanding of the how the future should be.

The actor-networks are normally demarcated by one rationality – i.e. a historically conditioned common understanding of how the reality is constructed – and it is this common understanding that unites the actor-network. Based on this rationality the actor network develops future scenarios, i.e. stories about how the future should be and what is to be done to reach that future state of affairs. In this context they may make use of various ideologies, i.e. systematic and codified renderings of the nature of reality.

The problem with approaches like this one is that they may underestimate the individual's ability to go beyond the borders of the actor network. Given that each and every one of us has a different upbringing and a unique life world, new perspectives may enter the arena, especially if this person has the strong will, the social intelligence, the communicative skills and the connections needed to convince others, the self-defence mechanism of the actor network may brake down.

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[22] 1948
[23] Cp. Olsen 1988; Egeberg 1989; Powell and DiMaggion 1991; Cyert and March 1992
[24] Luhmann 1995
[25] Callon 1980; Latour and Woolgar 1986

Admittedly, these are a lot of “ifs”. Most often individuals like these are not able to change the network, unless they get the help for external forces, being that political shifts or other shocks to the system. In the case of innovation policy this can be shifting governments, pressure from interest groups, economic and social upheavals that necessitates new solutions, new international trends, or the fact that the old generation “dies out” and leaves room for people that have grown up in another time characterized by other ideas and mentalities.

Rationalities in innovation policies in the Nordic countries

This set of Nordic rationalities originated in a study made by the Norwegian team, and may indeed have a strong Norwegian slant. However, we believe that the cultural similarities between these countries, and the fact that we have found many of the same conflicts in the other countries, justify an inclusion in this rapport. We consider this a first step towards a more extensive mapping the social construction of innovation policies in these countries.

The macroeconomic rationality

The macroeconomic rationality is based on a traditional macro economic approach to economic growth. Policy makers that operate within this rationality have a tendency to focus on financial measures like interest rates, currency rates, trade balances etc. They are mostly concerned with the economic framework condition, not with the internal life of the companies.

This way of thinking is closely connected to neoclassical economics and this tradition’s belief in perfect markets in balance. The relevant milieus often recruit new civil servants from university faculties steeped in the neo-classical tradition. This is for instance the case in Norway, where the Finance Ministry finds many of its economists at the University of Oslo, well known for its “Oslo school” of social economics. This way of thinking is often found in ministries of finance, and – to a certain extent – in departments in ministries of industry or economics in all the Nordic countries.

Given this strong neo-classical slant, innovation policy measures are normally legitimised with market failure arguments.

One rather extreme example of how this mentality may influence policy documents is found in the Norwegian Government’s Long Term Plan of 1997. Although this document includes a lot of thoughtful reflections on the complexities of modern society, the foundation of what was then called “The Norwegian House” – i.e. Norwegian welfare development – was reduced to “low growth in prices and costs, low interest rates, orderly state finances and a trade surplus.”[26]

[26] ”Det er lav pris- og kostnadsvekst, lave renter, orden på statsfinansene og overskudd i utenriksøkonomien.” St. meld. Nr. 4 (1996-97) *Langtidsprogrammet 1998-2001.*

The science base rationality

The science base rationality is mostly concerned with research taking place in the university sector, and especially basic science. Policy makers born into this rationality have a tendency to use arguments based on the linear model of innovation: The university scientists are considered to be the true innovators; industry only transfers these innovations to the market.

Today many policy makers belonging to this tradition will agree that the linear model is too simplistic. Still, they continue to fight for increased support to basic science, and are often not that interested in innovation processes taking place in and between companies.

A clear example of this rationality is found in the Swedish SOU1998:128 *Forskning 2000*, which to a large extent reduced innovation policy to policy for basic research.[27] It has also strong footholds in especially the Norwegian and Swedish ministries of Education.

Policy makers belonging to this rationality are often hostile towards the macroeconomic tradition, as they feel that proponents of that way of thinking do not truly understand the importance of basic science. Nevertheless, these two rationalities are actually in harmony in one important respect: they often think of innovation as something that takes place outside the economy.

The macroeconomists has placed technological change and innovation within a “black box” that is defined as exogenous. People belonging to the science base rationality often consciously or unconsciously equal this black box with university science (or – alternatively – university science and basic research done by large industrial companies). This is one reason why innovation policy so often is reduced to research policy.

The systemic rationality

The systemic rationality grew in importance after the publication of the final reports of the OECD Technology/Economy Programme in the beginning of the 1990s[28].

This rationality is based on a systemic view of reality: innovation is born out of the interplay between companies and other institutions in so-called national systems of innovation. Innovation is not primarily a result of science push. Instead the technological development is driven by the companies’ need to survive in a harsh environment (the market). Companies that are able to take part in efficient networks and develop their learning capabilities are more likely to survive.

Policy makers belonging to this tradition will normally focus on a wider spectre of innovation activities, including design, marketing, commercialisation, learning and networking.

[27] http://utbildning.regeringen.se/propositionermm/sou/tidigare.htm
[28] *Technology in a changing world*, OECD Paris 1991

This way of thinking has now become quite influential in the Nordic countries, especially in departments for industrial development, research and regional development. In Norway this rationality has also been expressed clearly in White Papers from the Ministry of Education and Research.

Within the Swedish ministry of industry, employment and communication the systemic rationale is for instance gaining ground at the expense of the macroeconomic rationale, which has become evident in some of the latest bills. The clearest effect of this rationale was the establishment of the Swedish Agency for Innovation Systems (VINNOVA) in 2001. The activities of VINNOVA are governed by the systemic rationale. The programmes launched address failures in innovation systems; being it national, regional or sectorial innovation systems. The VINNVÄXT-programme (Regional Growth through Development of Dynamic Innovation Systems) is an example of such a programme.

The Finnish Centre of Expertise Programme represents clearly the systemic paradigm. The programme is an epitome for current thinking in regional development. First, regional development has to be based on local strengths and expertise, which can give a competitive edge for the region. Therefore regional and local actors are encouraged to take a more strategic view on regional development. Secondly the programme emphasises networking (regionally, nationally and internationally) and co-operation as important elements in promotion of regional development.

The Icelandic Ministry of Industry and trade has co-organized innovation policy with regional policy on the basis of systemic innovation theory. The new Innovation Centre at Akureyri has been given a coordination role for innovative activities in regions outside the capital.

This rationality has also given birth to a new so-called “third generation”, “holistic” innovation policy, where policy makers try to involve other policy areas into the innovation policy process. Traditionally innovation policies have focused on policy areas targeting industrial innovation directly, i.e. industry policy, R&D policy and to a certain extent regional policy. Now they want to include policy areas that influence the innovative capabilities of firms indirectly as well, including transport policy, education policy and social and cultural policies. Both the Norwegian and the Swedish government have started political processes with this aim.

The entrepreneurship rationality

The entrepreneurship rationality is not as distinct as the three previous rationalities, and often overlaps with the systemic as well as the macroeconomic tradition.

Policy makers shaped by this rationality stress the need for the establishment of new, small, enterprises. This may refer to all kinds of companies, but these policy makers often focus on so-called “knowledge-intensive technology-based companies”.

People belonging to this tradition have a tendency to focus on the individual, the entrepreneur *(gründer)*, and his or hers ideas. Innovation policy therefore consists of instruments aimed at helping entrepreneurs develop their ideas and bringing them out into the market. While the systemic rationality is inspired by modern innovation theory, the entrepreneurship rationality makes also use of a separate brand of social science, the entrepreneurship studies.[29]

This way of thinking is becoming increasingly popular among civil servants working on industrial innovation and regional development. In Norway one may witness an increasing interest in entrepreneurship policy measures in the Ministry of Industry and Trade. SND has clearly noted this, and they are also discussing how to introduce such perspectives into their instrument portfolio.

The Swedish Business Development Agency (NUTEK) was established at the same time as VINNOVA. Its mission can therefore be connected to the systemic rationale. However, in comparison with VINNOVA, it focuses more on the development of SMEs, start-ups and clusters. Hence, the entrepreneurship rationale has an influence on the measures introduced by NUTEK.

The planning rationality

The policy makers belonging to the planning rationality are a dying breed. According to this tradition the state is to take an active, strategic, role in developing large research intensive companies, especially within so-called “heavy industries”. These companies are to serve as locomotives for the rest of industry.

The most extreme variant of this rationality was found in the Soviet Union. However, a more moderate version dominated Nordic industrial policies in the 1950’s and 60’s, when especially the social democrats used industrial development as a tool in the building of the new welfare state. This way of thinking is often combined with corporatism, i.e. close collaboration between the state and influential industrial organisations.

This tradition has lost its influence partly due to globalisation and the fact that international agreements have taken away many of the tools available to policy makers, but also because of an increasing scepticism as regards the civil servants’ ability to understand the complexity of society, predict the future, and plan and execute large policy reforms. Instead there is a tendency to focus on the need for plurality and many options. To mix metaphors: Instead of putting all the eggs in one basket, there is a wish to stimulate a large undergrowth of new companies, out of which some may become the champions of the future.

The situation today

When reading official policy documents one soon gets the impression that the systemic approach is the formal basis for innovation policies in all the Nordic countries. One must distinguish between political texts and political realities, however. If powerful people or institutions have not fully understood or accepted this perspective, they will inevitable weaken the systemic approach to innovation.

[29] *Entrepreneurship Policy for the Future* av Lundström og Stevenson, Swedish Foundation for Small Businness Research, Stockholm 2001.

On the other hand, one should also be aware of the fact that policy makers that are firmly based in the “systemic camp”, may nevertheless use arguments from other rationalities, partly because they honestly believe that they are complementary, and partly from pragmatic reasons: The arguments work in the political setting.

The latest innovation policy document from the Norwegian government, written by people in the Ministry of Industry and Trade, is clearly based on a systemic view of innovation. Nevertheless, the paper presents neoclassical theory side by side with what is called “innovation theory”. It goes to argue that

> “To a far extent there is unity *(sammenfall)* between recommendations made by innovation theory and neoclassical theory. According to both traditions both research and development, coordination and networking, advice and guidance, infrastructure and funding in an early phase important focus areas for policy measures.
>
> The main difference between the two main branches of theory is found in what questions they are trying to answer. While neoclassical theory in particular state the reasons for *what* areas industrial policies should influence, based on an understanding of markets, innovation theory has a stronger focus on *how* policy and instruments should be targeted, based on an understanding of what hinders and what encourages innovation and competitive abilities in industry *(næringslivet).*
>
> Neoclassical theory focuses more clearly on the individual company, while innovation theory is more concerned about interaction and learning in groups and environments. Because of this it should be possible to learn from both schools, thus gaining a more coherent theoretical basis for the use of direct policy measures.”[30]

The text reflects a very sophisticated understanding of the theoretical basis for innovation policies. The policy makers who have written this text are acutely aware of the conflict between the two dominant rationalities.

We may partly disagree with this rather pragmatic and eclectic approach. We believe that the macroeconomic understanding of reality is to a much larger degree incommensurable with the systemic view. That being said, there are many perspectives from neoclassical economics that are valid within a systemic framework. In this connection, however, it is interesting to note that the authors have found it useful to discuss the two traditions. One possible reason for this might have been to get the Ministry of Finance “on board.”

Policy learning

The previous discussion of rationalities may give the impression that the GoodNIP team favours a relativistic approach to innovation policies. It might seem that it does not

[30] St. prp. nr. 51 2002-2003, *Virkemidler for et innovativt og nyskapende næringsliv*, http://odin.dep.no/nhd/norsk/publ/stprp/024001-030016/index-dok000-b-n-a.html

matter what rationality the policies are based on, as they are all products of the human imagination, totally removed from reality in itself.

There is certainly no reason to believe that Nordic policy makers ever will get a totally objective view of reality. Policy makers are, like all of us, shaped by their own environment, and they see the world through "the glasses" of their own rationality. That being said, all practical experience shows that it is possible to develop a more nuanced, multifaceted and realistic view of society – that is "to get closer to the truth".

To a certain extent these learning processes can take place within a specific rationality, i.e. without provoking the self-defence mechanisms of the actor network. We see these learning processes reflected in an endless production of documents combining new statistics with well rehearsed arguments.

A continuously changing society requires, however, policy makers that are able to "go outside the box", and make sense of other points of view. This is a much more demanding and time consuming process, which requires wisdom, patience and bravery from the policy makers involved.

The following analysis of policy learning is partly based on work done within the EU TSER RISE-project,[31] which also had partners from Norway and Sweden. This material has been expanded and compared to practices in the other Nordic countries. In general the same patterns exist in Denmark and Finland as well.

Policy learning

Definition of policy learning
We define policy learning as the process underlying any changes in the political "behaviour" of an agency, its portfolio of policy instruments (institutions, programmes, funding schemes, regulatory frameworks etc.), objectives and management for or of these, their constitution and the relative weight of instruments in the portfolio.

We broadly regard policy learning as having taken place within a policy agency when the agency alters its policy behaviour, i.e. when it

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[31] RISE Research & technology organisations in the service economy http://centrim.bus.brighton.ac.uk/go/rise/index.htm. The following researchers took part: CENTRIM (Centre for Research in Innovation Management): Brighton Mike Hales, Jeff Readman; Dialogic Innovation & Interaction: Utrecht Pim den Hertog, Erik Brouwer; DIW (Deutsches Institut fur Wirtschaftsforschung): Berlin Brigitte Preissl, Ulrich Wurzel, Anja Dresenkamp, Christian Rickert; INETI (Instituto Nacional de Engenharia e tecnologia Industrial): Lisbon Margarida Fontes, Muriel Hinard de Pýdua, Rui Carvalho Diaz; Istituto di economia dell'impresa e del lavoro, Universita Cattolica del Sacro Cuore: Milano Laura Solimene, Claudio Farina; NUTEK (Narings- och Teknikutveklingsverket): Stockholm Lennart Norgren, Anna Backlund, Nils Markusson, Anna Sandstrom, Anna Nillson, Ingrid Petterson, Helena Haggblad. NUTEK has been reorganised as Vinnova (Verket for Innovationssystem); STEP (Studier i teknologi, innovasjon og ekonomisk politikk): Oslo Johan Hauknes, Thor Egil Braadland, Carl Drefvelin, Per Koch, Olav Wicken, Svend Otto Remoe, Morten Fraas, Nils Henrik Solum, Finn Orstavik; TNO/STB Centre for Technology and Policy Studies: Delft Jos Leijten, Jason Whalley, Paul Beije, Sander Kern, Sander Limonard, Imke Limpens

- alters specifications and orientations for subsidiary institutions, programmes, or the policy legitimisation of these, etc.
- introduces new or altered policy instruments or
- new internal and external monitoring or management systems,
- expands or contracts its main constituencies.

The process underlying these changes is a complex process including various forms of learning, types of competences and sources of knowledge.

The focus for our study has been “the policy maker”, meaning any elected person (politician) or appointed or employed individual (bureaucrat/civil servant) involved in developing and administering policies.

Models of learning
An organisation’s ability to develop relevant knowledge-based policies is to a large extent based on its ability to develop relevant competences, i.e. it is based on learning. We suggest four generic modes of learning:

- *Explicit conceptual delivery and acquisition*
  An explicit and direct interaction between the policy making agency and an external institution, furnishing new analytical perspectives, presenting and performing research to policy makers, contract work to commissions, agencies on specific issues or suggestions in new or altered policy initiatives or objectives etc.

- *Learning networks*
  Policy agencies are often involved in permanent or long-term networks where a primary objective is the sharing of information or other conceptual resources among its members. Such networks may include individual experts’ formal and informal professional networks, long term institutional networks, dialogue with the members of the constituency the relevant policies address, intra- or inter-ministerial networks, and international networks (e.g. EU and OECD-based working groups).

- *Benchmarking and other indicator-based or best-practice approaches*
  At one end of the spectrum are formalised indicator based reporting systems, at the other “one shot” or sporadic assessments, evaluations and analytical studies.

- *Continuous improvement*
  Of informal processes, most notable is learning-by doing, which generates capabilities and competences that are operational and experience-based. These processes and capabilities are shaped by the impact of an evolving policy “culture”, including the ministerial or departmental perception of the organisation's policy agenda; the governing, more general, political objectives and how they are operationalised, and divisions of labour between ministries and departments.

Individual and organisational learning
Some of the RISE case material respondents pointed to the discrepancy between individual learning and the learning processes of the whole organisation. For instance: Although the Research Council of Norway employs highly competent policy makers – in formal terms – with experience from science as well as industry, the organisation seem to lack an overall strategic competence building. In some respects the

competences of the organisation are not much more than the sum of the competences of its employees. Respondents from the Norwegian ministries gave the same impression: There is a lot of individual “learning by doing”, but the ministries as a whole seem to lack long term plans for strategic competence building.

Individual learning

A policy maker in a ministry or policy agency is normally set to administer and monitor existing policy instruments and to develop new ones. In doing so she will have to take a lot of factors into consideration. Among these are:[32]

- the wishes, ideas, rationality and ideology of the political leadership of the ministry, or – in the case of subordinate policy organisations – the political signals and demands coming from the relevant ministry or ministries
- the wishes, ideas, world views and ideology of the non-political superiors (civil servants), which is often equal to the rationality shared by this specific actor network,[33]
- public opinion, including social movements and organisations
- the media
- regulatory restraints
- financial restraints
- scientific expertise

One must also take her own personal and cultural background and interests into consideration – the *lifeworld* of this individual, to use the hermeneutic expression[34],

- personal experience
- education
- worldview and ideological background
- networks and contacts

And finally, there are various sources of information. These are of limited value if the individual does not now how to find, understand and use this information. On the other hand, the process of learning becomes much more difficult if relevant information is not readily obtainable.

Policy makers tend to use a wide array of information sources:

- newspapers and magazines
- newsletters
- World Wide Web

[32] Cp. Arthur Edwards: 'Scientific expertise and policy-making: the intermediary role of the public sphere', *Science and Public Policy*, June 1999.
[33] This does not apply to ministries in countries were large parts of the staff is politically appointed, as in the USA.
[34] As used by J. Habermas

- specialist databases, including relevant statistics
- books and periodicals acquired by the policy maker or her department
- books and periodicals from the library of the institution (if it has one)
- books and periodicals from public libraries
- government reports (including white papers and budget documents)
- reports commissioned by the government (green papers)
- reports from research institutes and consultants, including evaluations of institutions, programmes and other policy instruments
- in-house memorandums and reports
- conferences, seminars, national and international organisations and working groups

Although scientific knowledge does play an important role in policy development, any "linear" model depicting the policy maker as a person who designs new policy instruments purely on the basis of expert advice must be false. Not only is the policy maker forced to take other factors into consideration – in a democracy he or she is expected to do so.

However, many civil servants have emphasised the need for contacts in policy agencies, industrial organisations and research institutes that can assist the policy maker in gaining access to relevant competences. Hence researchers often play an important role as competence providers also outside the traditional relationship of commissioner/report producer.

The competence need of the policy makers
Policy makers look for various competences when hiring new employees or asking researchers for help. In the RISE interviews policy makers expressed a need for

- An understanding of the different cultures of industry, universities/university colleges and industrial institutes. Work experience from the respective organisation types was mentioned as a major contributor to such competences,
- Knowledge about relevant science and technology,
- Factual knowledge about the relevant industrial sector (structure, organisation etc.),
- Awareness of what is currently going on in research, industry and policy development,
- Knowledge about what it is possible to do and how to do it (available instruments and the limitations inherent in the policy area, system or technologies),
- Experience from large development projects,
- An inclination to act, even if one have a partial and imperfect understanding of all the dimensions of the topic at hand,
- An insight into the policy development in other countries,

- An insight into the present interests of managers on various levels in the relevant industries or parts of the system.[35]

This fits well with the information gained through the GoodNIP study.

As one can see the policy maker has to develop a theoretical and factual insight into the nature of the industrial innovation system. This he or she has in common with researchers studying industrial innovation. However, the policy maker must also know the workings of the political system and the relevant policy instruments. Moreover, this knowledge must go far beyond an understanding of organisational charts and formal procedure. They must develop an intimate knowledge of the cultural aspects of the political and administrative environment, and learn what is possible within the present administrative structure and political context.

This is why it is important that policy makers understand the roles of rationalities. If there is a gap between world views, it helps to know what this discrepancy is about, so that one may make efforts to bridge that gap by the use of various didactic means.

Researchers must also be made aware of these conflicts. Researchers have the duty to give their advice on a more independent basis, regardless of whether this advice is "politically correct" or politically feasible at the present time. If they do not, research will very easily be reduced to simply a "legitimising" agent of status quo.

The researchers still need to gain a better insight into the political and administrative processes in the public sector, however, and into the everyday life of the policy maker. They need this knowledge in order to understand the competence needs of the policy maker and in order to produce a realistic analysis of the consequences of the various findings and suggested policy instruments.

The learning processes of policy makers

Our studies of policy learning cover only a few countries, a few institutions and a short period of time. Hence it is impossible to generalise the results, across countries, cultures and policy-making institutions. Still, it seems that variations in national specificities, going far beyond formal structures of organisation and divisions of labour, are extremely important in explaining trans-national variations in operations and procedures – including the way social science is used.

Nevertheless, innovation policy makers in Europe all face some of the same challenges, a reflection of their shared basic responsibilities and tasks; to design, fund, implement, administer, control and evaluate public policies, institutions, programmes and regulations.

Recruitment
The formal background and previous experience of policy makers are important. Actor networks often hire "clones" of the existing staff. To a certain extent this makes sense, as it simplifies internal communication and understanding. Hence it makes policy

[35] RISE: Swedish results of interviews on policy learning.

learning within the existing rationality much easier. On the other hand, this tactic also stiffens the actor network's resistance towards change. It slows down the process of policy innovation by excluding alternative perspectives and conflicting views.

Some policy institutions tend to hire predominantly qualified scientists and engineers from universities, colleges, research organisations, firms and from other policy institutions. This should in and of itself contribute to enhancing the policy systems absorption capabilities of scientific and other research, not just as a consequence of the competences, but equally as a result of their personal and professional networks. Such recruitment requires, however, that the scientists and engineers are able to adapt to a different cultural setting with quite different rules of the game.

In some countries salaries of ministerial officials – or civil servants – tend to be lower than those of comparable positions in the industry sectors. Hence it comes as no surprise that labour mobility from industry to the policy systems is weak. In institutions with closer contact and interaction with industry, salaries tend to be higher and the labour flows of experts from industry to the public sector are generally more extensive[36].

Networks
The major source of competence building is day-to-day practice and collaboration with colleagues and other people involved in the processes of policy development. Hence interviewees mention networks and personal contacts as the most important sources of information and knowledge.

From our contacts we gather that this contact building primarily is an individual activity with little managerial input, although programme steering committees and budget reference groups may be perceived as institutionalised instruments for networking.

Educational background
The educational background of policy makers is of importance. Most of them have a university or college background, normally at a graduate level. Many of them consider themselves generalists, and claim that the particular disciplines taken are not as important as the fact that higher education gives them the ability to take part in the political culture and find, understand and utilise relevant literature and research.

In other institutions and departments, the management tends to prefer recruits with a specific type of education. There is, for instance, reason to believe that ministries of industry, economics or finance tend to have a larger proportion of economists than many other ministries and public institutions.

International learning in innovation policy[37]

International organisations like the OECD and the European Union have paid much attention to transnational learning between countries in the innovation policy area. The EU Trend Chart on Innovation, for instance, recently arranged a separate workshop for

[36] Nås (1998). See also OECD 2001
[37] Additional source: European Trend Chart on innovation. Theme-spesific Country reports on Denmark, Finland, Norway and Sweden for covering period to March 2002.

a discussion of such processes. Learning from other countries is seen as an important tool for improving the design and benchmark national policies and programmes.

There is no exact information available of the importance given by Nordic policy makers to transnational policy learning. Therefore it is not possible to make any far reaching conclusions of the issues of importance in innovation policy making in Nordic countries. However, there are some examples, which exemplify the value policy makers and civil servants assign to international experience.

In Sweden there has been established a group consisting of representatives from trade and industry and Government officials. The group has been evaluating ways to bring about a more efficient industrial policy. The group has been using benchmarking as a method to evaluate the outcome of the industrial policy in Sweden. The comparison with other countries has given an opportunity for them to find areas where Sweden needs to intensify its policy efforts.

In Finland international examples as a source of policy learning have had a significant effect on R&D and innovation policy making. Over the years a number of innovation policy measures have been based on international examples. In this sense Finland has followed a catch-up strategy when developing national science, technology and innovation policies. Recently this situation has changed, not least because of the rapid advancement of the IT and telecommunication sectors. Instead of being a follower Finland is increasingly seen as a model country of successful innovation policy. Still, Finnish policy makers are keenly looking out for interesting examples from abroad.

Icelandic policy makers have also made use of international models recently. The Minister of Education and Science together with a delegation has visited Finland on two occasions recently – in order to learn from the structure and function of the Finnish science, technology and innovation system.

Knowledge from relevant developments abroad is often rooted in the everyday routines of policy makers and other experts working with innovation policy issues. Both policy makers and experts of the Nordic countries are actively participating in international networks and working groups organised, for example, by the OECD and the European Union. These networks are facilitating knowledge flows between participating countries. Several Norwegian ministries have established cross-ministerial working groups discussing and preparing national participation on OECD committees and working groups. The national working group for the participation in the OECD Working party for technology and innovation policy (TIP) has actually functioned as a forum for general discussions about innovation theory and policy trends.

Technology attachés at the embassies and similar arrangements provide a well established source of information on policy development in their host countries/areas. Norway has, for instance, science policy advisers at the embassies in Washington D.C. and Brussels, who report on R&D policies. Swedish ITPS has Science & Technology Offices situated in Washington, Los Angeles and Tokyo with the aim of analysing the development of growth policy at national as well as international level. The Finnish Tekes has also offices with technology counsellors in the United States, Belgium and Japan. A new Tekes office will be opened in China in Summer 2003.

Ad-hoc surveys and missions undertaken by policy makers are another way of studying new trends and innovation policy measures. More long-term visits through specific exchange programmes for policy makers are rare. Time limited assignments in international organisations, such as the EU Commission, OECD or World Bank are more typical ways of obtaining longer-term experiences and practical insights.

In general, it seems that the awareness of the need to monitor and learn from other countries is growing among Nordic policy makers. However, the constraints limiting policy learning between countries are many. The main factor hindering policy learning is the lack of time. One solution implemented in the Nordic countries is the commissioning of studies from research institutes and universities. This strategy can be useful to the extent that the relevant institutes are able to build up their competences in the field of innovation policies, but it does not provide the ministry employees with the internal learning processes needed. Moreover, evaluations of national innovation policy instruments and arrangements offers sometimes an opportunity for international policy learning. The fact that foreign experts are used extensively as evaluators or as members in evaluation panels in Nordic countries supports this kind of experience sharing. Often, though, this possibility is not explored systematically – not least because of time and resource constraints.

Anyway, it is important to remember in the context of transnational policy learning that models or instruments that have been considered best practice elsewhere cannot always be transferred successfully to another national innovation system. Learning from experiences from abroad, or even between regions of the same country is always a complex and ambiguous process due to the institutional, political, cultural and historical differences.

Researcher/policy maker interaction

Our studies have shown that one of the most important impediments for an effective utilisation of innovation research in policy organisations is time – or, rather, the lack of it. The hectic pace of modern ministries and directorates leaves often little time to reflection. This does not mean that there is not room for learning. Policy makers develop their competences through their day-to-day practice, but they often lack the time needed to read through long reports or follow theoretical debates in the research community. Consequently, learning tend to be dominated by single loop learning – to use Argyris' concepts[38] – while opportunities for second loop learning is severely constrained and third loop learning is virtually absent.

Moreover, many policy makers say that they need information and advice of direct relevance to the development of concrete policy instruments. Their patience often runs out when researchers start deliberating what they perceive as "purely theoretical aspects" of certain hypotheses or issues.

[38] For Argyris and Schön earning involves the detection and correction of error. People often look for another strategy that will address and work within the governing variables when something goes wrong *(single-loop learning)*. Alternatively people may try to alter the governing variables themselves (*double-loop learning*), modifying an organization's underlying norms, policies and objectives. This is a more rare form for learning. Argyris and Schön (1974).

In order to make certain that research is used and understood it is therefore important to find other avenues for communication of research results. Several of the policy makers contacted reported that they found an active dialogue with researchers very useful. Discussions in workshops and seminars seem to be efficient; more so than large conferences where participants passively listen to selected speakers.

Commissioning research – phases
The most important meeting place for researchers and policy makers seem to be the process of commissioning research and evaluations. Such processes are divided into several phases:

- **The preliminary phase,** where policy makers try to determine the nature of the question that is to be asked. Informally, policy makers may get in touch with researchers that are part of their network of contacts. Moreover, the issue at hand may be caused by questions raised by other reports or evaluations made by researchers. In general, however, researchers are not much involved in this phase.

- **The commissioning phase**, where policy makers get in touch with one or more research institutions in order to get suggestions on how this research can be carried out. This can be an important learning phase for policy makers as well as researchers. The researchers must try to understand the needs of the public institution in order to target the research or evaluation process as accurately as possible. The policy maker need the expertise of the researcher to map the status of research in this area, to decide what can be done, within a certain period of time, to a given price. By discussing these matters with researchers the policy maker may learn more about research in this field.

- **The research phase**, when the research is carried out. The policy makers may follow this part of the process through follow up meetings, preliminary reports, workshops, seminars, participation in reference groups etc. The feedback they give may teach the researchers more about the needs of the policy makers. Furthermore, as the policy makers often are experts in the field of active innovation policies, they may give the researchers useful feedback on the content of the preliminary material, and input on how to proceed.

- **The finalising phase**, where the research results are delivered, normally in the form of printed material, seminars and conferences. Several policy makers have told about reports and evaluations that have ended up i a drawer, never to be used in policy development. Others felt that the dissemination of results through seminars and conferences is more important than the final reports in themselves. One reason for this is the lack of time for reading. Some policy makers admitted that they often read executive summaries only. However, if the reports are to be used in the development of new policies and new policy instruments the results will often be included in policy documents written by the policy makers. If this is the case, the chances are that the reports will be thoroughly read by these policy makers.

- **The post-publishing phase**, where policy makers may contact researchers in order to clarify information given in the reports, where researchers may be asked to present the results in meetings with the policy institutions, and where researchers may be asked to carry out new research based on the previous mission. Often policy organisations have agreements with R&D institutions, where the policy makers are allowed to discuss relevant issues with researchers, without making a new payment or signing a new contract. This service is often part of agreements made in connection with basic funding or long-term contracts for competence building.

The fact that an interaction between policy makers and researchers *may* take place during these various phases does not mean that it necessarily *does* take place. The process does show, however, that there are potentially many stages where researchers and policy makers may interact and learn from each other.

The GoodNIP project is funded by the Nordic Industrial Fund, an institution that plays an important role in engendering innovation policy studies for Nordic policy makers. This institution insists that dissemination be an integrated part of the research process. The project teams are to establish reference groups, preferably including relevant policy makers, and interact with policy makers in seminars, work shops etc. This practice is becoming increasingly common in relevant Nordic commissioning institution, as is the request for a project Web site, project specific workshops etc. This indicates an increasing awareness of the need for more coherent policy making processes.

Strategic learning
However, among those we have had contact with in the course of this work and at other times, few institutions was able to demonstrate a strategic approach to learning – as a way of improving the strategic orientation and the operations of the policy system. Policy learning is rather an indirect side effect, recognised but insufficiently focussed.

There are several reasons for this, but nevertheless they point to a rather fundamental paradox. Policy makers in the area of industrial and innovation policies have generally assimilated the message of the importance of "learning" – for focussed development of techno-economic capabilities and competences – for innovation performance, and hence for improving the operations and effectiveness of the firm. It is a paradox that policy systems – generally highly knowledge intensive and strong pressures for change – tend to deemphasise, or even neglect, the implications of the arguments for their own activities.

Interaction vs. independence

The role of scientific advice
Arthur Edwards points out (Edwards 1999) that although the sciences have lost their authority based on knowledge and unanimous expertise; this has not led policy-makers to reduce their appeal to scientific advice-giving.[39] Edwards points to Habermas, who gives science a role in the communication between citizens and policy makers in the "public sphere".

Edwards argues, however, that both the appeal of the policy-makers to science and their uses of scientific expertise are often tactically motivated and dependent on a variety of factors that bear on the "political attention" an issue receives. Hence the potential impact of scientific insights on the public sphere is anticipated or used instrumentally by policy makers. On the other hand scientists participate in public agenda-setting and

[39] Cf. Weingart 1999.

make use of media attention in furthering their normative stands on issues as well as their own strategic aims.

The use of policy oriented research

“Deconstructivist” research within the sociology of knowledge, philosophy and the history of ideas have increasingly interpreted the use of science, research or any form of communication as tools in struggles for power and influence (Aarnes 1987). However, one should be careful reducing all uses of research input into tools of opportunism.

Interviews and workshops organised by GoodNIP institutions do indicate that policy makers may commission, select or use results that strengthen their own position and arguments. We have often witnessed policy makers (and scientists from the universities!) focusing on indicators that seem to support an analysis of reality that strengthens their position in the struggle for R&D funding. Indicators that point in another direction are not discussed with the same enthusiasm. There is reason to believe that policy makers commissions evaluations, not solely to gain insight into the present state of affairs, but to be able to legitimise reorganisation or political reform. Hence one can clearly argue that policy makers do not always use research results in a balanced, fair and “objective” way.

On the other hand, there is no reason *not* to believe policy makers when they say that they commission research in order to gain insight into the workings of the innovation system or the effectiveness of various policy instruments. Not only are many of these policy experts genuinely interested in the “academic” aspect of innovation and learning, they also need this knowledge in order to develop new, effective policy instruments. Their legitimacy as civil servants rests to a certain degree on their ability to produce effective policy actions that can strengthen the political credibility of the politicians.

Politicians may also be genuinely concerned about finding solutions that might help industry, and even if this is not always the case, their success as politicians rests on their ability to be perceived as competent and pro-active. This does not guarantee a realistic utilisation of relevant research – like most human beings, politicians may find it useful to suppress information that does not strengthen their own cause – but it may also stimulate their interest in the topic at hand, making them more receptive to new research.

Several of the policy makers contacted are very aware of ethical problems related to the use of research in policy development. Their interest is partly grounded in pragmatic concerns. They argue that the credibility of the research and the use of it depend on trust. If any party can raise doubt about the validity of a report or an evaluation, it might easily become useless from a policy perspective.

This line of reasoning often brings up the role of public opinion or the public sphere mentioned by Edwards. These policy makers argue that the best defence against abuse of research or a lack of impartiality on the side of the researcher is an open public debate where alternative research bodies may criticise the findings.

Others perceive a possible conflict with more classical ideas of what science and research should be. This is often based on the ideal of the disinterested natural scientists. Many researchers hesitate when asked to give concrete policy advice, often on the grounds that it is the task of policy makers to do so – researchers shall only supply the factual base for this decision-making.

The neutrality of the researcher
There is also the idea that researchers should stay neutral in political matters, and that their objectivity may be threatened if they engage in the development of policy instruments. This understanding is based on traditional views of the ideal university researcher as a person that stands on the outside of society, looking in, giving the necessary corrections to 'manoeuvring politicians' and 'predisposed policy makers'.[40]

The policy makers are presumed to be too immersed in the complexities of social leadership to get the overview needed to make unbiased judgements. And interestingly enough, when policy makers commission research from researchers, it is often to get an independent view and a more refined understanding of the problem at hand. An independent review may also give political legitimacy.

There may indeed be a possible conflict between the need for dialogue and understanding between policy makers and researchers on the one hand and academic independence on the other. This conflict must be taken seriously and should be discussed thoroughly.
Our experience indicate, however, that it is very hard – if not impossible – to uphold the ideal of the isolated observer. Not only are researchers – like all human beings – influenced by ideological trends and personal preferences, ambitions and prejudices, they also need a close dialogue with the users in order to understand the commission, and to produce relevant and useful research. As we have seen, this dialogue is also needed to strengthen the learning processes in the political apparatus.

There is, on the other hand, a danger that researchers may be "held hostage" by policy makers that deliberately or unconsciously try to influence results in a way they find useful, for instance in order to legitimise a certain policy. Policy makers may also interpret results in a certain way in order to achieve political goals.

There may also be instances when the researchers have their own political agenda or when they consciously or unconsciously try to please the commissioners in order to get more funding. Hence it is essential that applied research of this kind uphold the same methodological and ethical standards as other forms of science and research. One must make certain that there exist several alternative research institutions or environments studying related fields, so that there might be fruitful discussions and scholarly criticism.

Several policy makers have argued to us that researchers should be careful suggesting one – and only one – policy solution. The complexity of both innovation systems and political systems gives reason to believe that there are no optimal solutions to specific policy problems. There is rather a wide array of various combinations of possible policy instruments and organisational structures. When asked for concrete policy advice, it is probably better that researchers map possible avenues of action and give an analysis of potential consequences following the various alternatives. It can be useful to give

[40] Often called the "Weberian ideal" after the German sociologist Max Weber.

examples from other countries, these policy makers argue, although one should always discuss the main similarities and differences between the relevant national innovation systems.

As there is no single solution that can be objectively characterised as “the best”, it must eventually be up to the policy advisers and policy makers to use their experience, expertise and faculty of judgement to suggest concrete policy instruments. The researcher has the luxury of withholding his or her final judgement arguing that there is need for more research. It is the task of the policy maker to make decisions, in spite of a lack of knowledge.

Systemic failures in the policy apparatus

Even if researchers and policy makers in the field of innovation policy have succeeded in developing a common frame of reference and are able to discuss these matters in a constructive and useful manner, there remains another stumbling block for the development of a modern and flexible innovation policy. This is the struggle that takes place within the policy apparatus.

The political system consists of a large number of institutions, organisations and ministries. Each institution is divided into various departments, and each of them may have their own culture, ideology and policy, and each of them will normally be dominated by one rationality. Several of the RISE interviewees pointed to the importance of the leaders of the relevant departments; their interests, opinions, contacts and psychology. In a small organisation one person may to a certain extent shape the development of policies within its own field of interest. The researchers often communicate with lower or medium level civil servants and policy advisers. Whether the managers of these units absorb and make active use of the competences in the organisation depends on their ability to communicate with the rest of the staff.

These managers must also be able to explain the policies suggested by this unit to managers and politician higher up in the system. If there is a struggle for influence and funding going on inside the organisation, the fate of a policy instrument may rest on the manager’s ability to convince the upper echelons of its usefulness.

Policy instruments based on systemic innovation theory often conflict with traditional macroeconomic thinking and research policies. The manager cannot take a common frame of reference for granted. The struggle for influence will therefore often become a struggle to establish a new worldview and a new vocabulary. From a didactic point of view this is a very difficult task, especially as the senior managers and political leaders often are older, experienced men and women. Through a long life they have developed their own perspective and their own ways of doing things, and they can find it hard to abandon this rationality in favour of new and seemingly radical ideas. Even if they do accept the new way of thinking, they may avoid using arguments based on these theories in fear of loosing the struggle for money and influence.

There may also be a conflict with other departments and organisations that are not involved in innovation policy formulation. This is particularly the case in the central government. In the annual budget cabinet meetings, the ministers will have to convince his or her colleagues about the wisdom in funding their particular policy instruments.

Although it seems that the success of a certain policy to large degree rests on the competences of individual managers, their competences are interconnected with the competence flows in the policy system. The preliminary studies made by RISE and GoodNIP may indicate that there are large differences between organisations as well as countries in this respect. It seems, for instance, that the culture of Norwegian, Danish and Swedish ministries are characterised by a rather "flat" command structure, meaning that junior civil servants and policy advisers can communicate with the managerial level in a fairly efficient way. This means that the competences developed in co-operation with researchers more easily will reach the political level of the system.

Moreover, innovation policy is not that politically or ideologically charged in these countries. There seems to be a broad consensus as regards the overall policy goals. This leaves more room for civil servants to suggest and implement new policy measures. Nordic R&D and industry policies are increasingly based on innovation systems theory and this development is to a large degree based on bottom up initiatives, i.e. the new policy instruments has often been based on suggestions made by the bureaucracy, not by the parties or the politicians.

In other countries, like Germany, policy development is to a larger extent characterised by a top down culture. This may restrict the flow of new ideas from research and lower level civil servants. On the other hand, politicians may induce the shock embedded agent networks need in order to assimilate new rationalities. The Norwegian strategy for a new holistic innovation policy is partly based on a top-down initiative, as is the establishment of the new Danish super-ministry for research and innovation.

Technopolis and the University of Ottawa have made several interesting observation regarding the organisation of innovation policy governance in a recent report.[41] Patries Boekholt, Erik Arnold and the other researchers note that although integration and co-ordination are high on the agenda few countries have actually found good governance solutions to cross the boundaries between science and innovation policy, between the sectoral policy domains and between disciplinary organised funding agencies. They note however, that "co-ordination seems easier to achieve when there is extra money, or where those involved have other strong incentives to co-operate."

There are probably several reasons for this. The supply of additional funding or "fresh money" probably makes actor networks less defensive or more experimental. They suddenly have the room to be more daring as well as forgiving vis-à-vis their "competitors". As for "strong incentives to co-operate" these may be interpreted as shocks to the system, being that an economic crisis followed by an intense search for new solutions or a new ambitious minister with a different view of reality.

If high level policy makers and politicians perceive that important institutions have grown stale and conservative, they may also induce such a shock by implementing institutional reforms. This was partly the reason for the unification of the Norwegian research councils in 1993 – the existing institutions seemed incapable of effective co-operation – and the present "Quality Reform" of the Norwegian university and college sector. The success of such reforms rests on the ability to keep the competences present

[41] Boekholt 2002.

in the system, while at the same time reshuffle the staff to the extent that the old actor networks are broken up. According to the Technopolis evaluation of the Research Council of Norway, the 1993 reform failed in this respect. The old research councils to a large extent survived as departments in the new Council.[42]

Differences between the Nordic countries

Although there are great similarities as regards policy learning in the Nordic countries, there are also profound differences. We will point our readers to the historical expositions in the GoodNIP reports for more information on this aspect.

Iceland is in a special situation in that the country is so small. Often one person will have to take the responsibility shared by scores or even hundred of persons in other countries. The RANNIS representative in the GoodNIP team is for instance responsible for Iceland's participation in quite a number of international organisations and working groups, especially in the OECD and the EU. These are functions that are divided between several civil servants from ministries and agencies in the other Nordic countries.

The advantages of having such a small policy system is that cross-department communication may become easier. Given that several functions are literally *embodied* in one person, it is also easier to integrate various policy fields. On the other hand these persons are put under a lot of pressure. They do not have the time for in depth studies, and they often lack the number of colleagues needed for proper discussions. Nor does Iceland have the same type of advisory research based institutions as the other countries (cf. VINNOVA and STEP).

The Finish case is special in that Finish innovation policies changed drastically at the beginning of the 1990's due to the loss of the markets in the former Soviet Union. This shock to the innovation policy system clearly reduced the resistance of several actor networks, and paved the way for an OECD inspired systemic innovation policy. Dr. Erkki Ormala, the chairman of the OECD Working Group for Technology and Innovation Policy (TIP) did, for instance bring home some of these new perspectives. That being said, many of the conflicts presented above, also remains in Finland. Moreover, it seems that the ability to change is not so apparent now that the crisis is over.

The other Nordic countries have not faced the same crisis as Finland, which means that many of the older rationalities have a much stronger position. Moreover, it seems that some policy systems are beginning a process of going beyond the most significant dichotomy, the one between the macroeconomic rationality and the systemic. Instead the systemic approach – which has now become the established one - is enriched with new perspectives, especially from the entrepreneurship tradition.

To give one example: In the late 1990's Denmark saw a change in rationality within the political establishment. The large technology programmes of the 1980's ended after a

[42] Eric Arnold et. al.: *A Singular Council, Evaluation of the Research Council of Norway*, Technopolis, December 2001.

few years without a clear sense of direction. Policymakers began to focus on the importance of small and new firms and their role in the innovation system. New innovative firms were seen as a key factor in the knowledge intensive economy, which had to be supported.

Consequently a number of science parks emerged where small innovative firms could grow and form networks with other small high-tech firms. This entrepreneurship rationality went much further and defined several programmes providing funding for start-up companies. The focus of the programmes is to promote new technology by providing funding.

The current Danish research and innovation policy has evidence of both the systemic and the entrepreneurship rationality. The government focuses on the development of a Danish knowledge system consisting of firms, knowledge institutions, and framework conditions for entrepreneurs. Moreover, this new integrated way of thinking includes the holistic approach we also find in Norway and Sweden. Maybe we are facing a new "holistic" rationality where the goal is to use more parts of society to stimulate innovation and competitiveness. In this perspective the new rationality actually has some resemblance to the planning rationality where a central core functions as drivers for welfare development.

The world beyond

Our studies of innovation policy system development have shown us that sound innovation policy advice not only depends on a proper understanding of the industrial innovation system. The researchers must also gain insight into the nature of the system of policymaking, its institutional structure, its culture and social framework. Like companies and clusters, this is also an arena for learning and innovation, although the policy makers are operating under different 'market conditions' than company managers and employees.

It should also be said that in one respect this system of policy making is actually part of the overall national system of innovation. This does not only apply to public institutions for R&D, financial support and innovation services. It also applies to the political and administrative apparatus that design these policy instruments. Their understanding and their decisions may have a profound impact on the working conditions of firms.

We therefore believe that innovation research should increasingly focus on "innovation policy innovation". Hopefully, this note can function as a starting point for such studies.

Policy recommendations

GoodNIP proposes that all relevant ministries and agencies develop strategic plans for policy learning, plans that include:

- **Concrete measures for life-long learning**
  Policy institutions should make active use of workshops, sabbaticals, courses and other forms of training. There should be exchanges of employees for a limited period of time, so that policy makers may learn to know other

institutions more intimately. Furthermore, there should be implemented more radical recruitment policies, in order to avoid the clone problem (leaders employing people sharing the same rationality only) and in order to get a more even distribution as regards age, gender and educational background.

Moreover, policy learning should be made an obligatory part of work descriptions and employment contracts, and the institutions should identify the resources that are to be allotted to such learning.

- **Strategic use of participation in international organisation like the Nordic Council, the OECD and EU, and in international conferences.**
  It is important to distribute the participation between more policy makers, so that more of them get the benefit from international experience and learning. International travels should not be seen as a fringe benefit for senior civil servants, but should be used as a tool for the training of new employees. It is important that the experience gained by these policy makers is shared with others.
- **The establishment of new forms of cross-organisational working groups.**
  Informal networks are an important part of policy learning, but they cannot be the only form for co-operation across departmental and organisational borders. High level forums are important tools for making the necessary policy decisions, but will often not give the necessary room for in depth discussions and extended policy learning. One way of improving such communication is to establish ad hoc or permanent medium to low level working groups given the concrete task of producing policy analysis and recommendations. Not only may such working groups lead to policy learning by themselves, they also contribute to lower the fences between institutions.
- **The establishment of social arenas.**
  It has been said that the most important part of any conference or work shop is the coffee breaks. During intermissions and meals delegates learn to know each other. They gain useful information and establish new venues for communications. Policy organisations should be encouraged to use this phenomenon actively. One way of doing this is to arrange common conferences for several departments or institutions. One should see to it that the arrangement takes place at a distance from the ordinary work place and that there is ample time for social interaction.
- **Coherent plans for the commissioning of innovation research and evaluations.**
  In all the Nordic countries the authorities make active use of evaluations and commissioned reports. However, this is often done on an ad hoc basis, without taking the needs of other relevant policy institutions into consideration. In some areas – but not all – it will therefore make sense to coordinate such commissions in a better way. It is also important to systemize the use of already existing evaluations and reports and see to it that they are distributed to all relevant policy makers.
- **Closer interaction with relevant research institutions.**
  Research institutions should not be understood as “report factories” that can produce policy advice on a totally independent basis. Innovation policy research institutions should indeed uphold the standards of unbiased and critical research,

but they cannot gain an understanding of policy development without a close interaction with policy makers. Such interaction will also gain policy makers, as they are more easily kept up to date on the latest developments in innovation theory, methodology and research.

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3. Nordic Innovation Indicators

By Rannveig Røste and Per Koch

Introduction

The aim of this chapter is to present an overview of indicators of relevance to innovation policy in the Nordic countries. It is important to keep in mind that although the five Nordic countries are similar in many respects, there are also historical, economical, cultural, political and structural differences. These indicators can therefore not be used as a "soccer league table" for picking out winners and losers. A weak performance in one indicator, may have a perfectly sensible explanation, and does not necessarily imply policy failure.

There are some additional tables in the statistical annex at the end of this report (tables marked A).

Structural and Macroeconomic Indicators

The Nordic countries consist of five states – Denmark, Finland, Iceland, Norway and Sweden – and three autonomous territories – the Faroe Islands, Greenland and Åland. The Faroe Islands and Greenland are both part of the Kingdom of Denmark, while Åland is part of the republic of Finland. In this report we will normally not treat these three autonomous territories separately[43].

Population density

With a population of only 24.4 million distributed at a total area of 3.5 million square kilometres, the Nordic countries show one of the lowest population densities in the world. The low density is primarily due to the fact that large parts of the Nordic countries consist of marginal areas, where natural conditions make extensive settlements impractical or extremely expensive.[44]

Table 1.1: Population in thousands in 1990 and 2000

Country	1990	2000
Denmark	5135	5330
Faroe Island	47	46
Greenland	56	56
Finland	4998	5181
Åland	25	26
Iceland	256	283
Norway	4233	4478
Sweden	8591	8883

Source: Nordic Statistical Yearbook 2002

[43] In some of the background statistic in chapter one, distinct data for Farao Island, Greenland and Åland are included. In the rest of the statistical report these territories are included in the data for, respectively, Denmark and Finland.

[44] Nordic Statistical Yearbook 2002

The general low number of inhabitants[45] could imply a relatively low production capacity compared to more densely populated countries. However, most modern economists do not consider this a problem. The present internationalisation and the fact that all countries are part of the EEA area, mean that one might just as well consider these countries regions in a larger European area. Manpower and business partners are available, if one is willing to go beyond national borders.

What's even more important is that these countries can present a very high educational level, and the lack of manpower is therefore partly compensated by the fact that the countries have very skilled workers. The generally high income levels and cost of living means that many companies will find it hard to compete on prices. On the other hand, they may compensate for this by making high quality products with a high "knowledge intensity", but also in more traditional industries.

Education

The companies' ability to innovate rests on their ability to learn. The companies' ability to develop relevant competences is dependent on the employee's ability to learn. Their ability to learn is again based on a wide variety of factors, including their work experience, the cultural setting, work organisation and leadership. One of the most basic elements, however, is the presence of relevant education. What is relevant and what is not can be discussed. In a constantly changing economy "learn how to learn" is just as important as any factual knowledge. That being said, the presence of good educational institutions is of outmost importance in any innovation system.

The OECD and EUROSTAT educational attainment data presented here derive from National Labour Force Surveys. The classification used is the International Standard Classification of Education (ISCED-97)[46]. This classification system covers both the level and the field of education[47]. Figure 1.1 presents an overview of the educational attainment in the Nordic countries, in grouped levels.

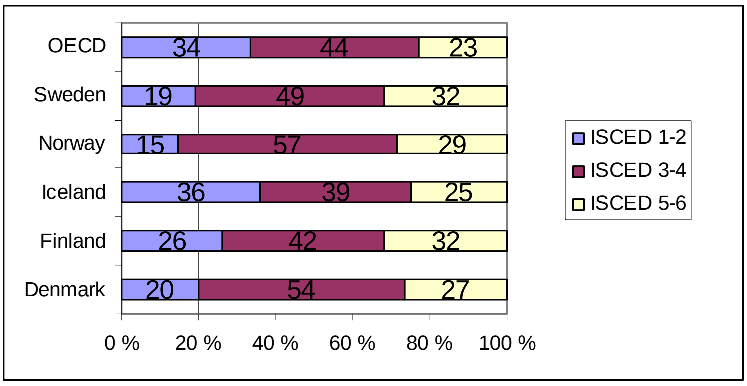
In all the Nordic countries comprehensive education is compulsory and local authorities finance these schools through general grants from the state. Most young people enter some forms of continued training after nine to ten years of compulsory schooling. Compared to other OECD countries the number of people taking tertiary level education (i.e. the university/college level) is relatively high.

[45] For statistical use, however, a very low population number as in Iceland can result in statistical errors regarding the distribution of the normal curve if the response rate or registered data is low.

[46] For detailed notes see the OECD publication: *Classifying Educational Programmes, Manual for ISCED-97 Implementation in OECD Countries, Edition 1999.*

[47] Levels are numbered 0-6, where level 0 covers pre-primary education, level 1 primary or the first stage of basic education and level 2 lower secondary or the second stage of basic education. Level 3 covers upper secondary education and typically begins at the end of full-time compulsory education, and level 4 covers post-secondary non-tertiary education. Level 5 covers tertiary education, and level 6 advanced research qualifications at the doctorate level.

Figure 1.1: Educational attainment of the population, 2001[48]



Source: OECD 2002: Education at a Glance

When comparing the Nordic countries one must take into account the different educational systems and the fact that some types of education are difficult to place. These factors might account for some of the differences in the share of population obtaining a certain level of education.

Level 5 of the ISCED-classification (i.e. tertiary education) is further subdivided into tertiary-type A (5A) and tertiary-type B education (5B). The tertiary-type A education is largely theory-based and designed to provide sufficient qualifications for entry to advance research programmes and professions with high skill requirements. Tertiary-type B programmes focus on practical, technical or occupational skills for direct entry into the labour market, and are shorter than those of tertiary-type A.

For tertiary education type-B in the OECD countries the country mean is 8 per cent, and on average 15 per cent of the population has attained education of tertiary type-A or level 6 (doctorate level)[49]. Among the Nordic countries, Denmark has the highest educational attainment for tertiary education type-B with 19 per cent and Norway the lowest with 3 per cent. However, the picture is reversed for tertiary type-A where Norway has the highest on 26 per cent and Denmark the lowest on 8 per cent.

A detailed statistical overview of graduates of the two tertiary types is presented below in table 1.2.

[48] Distribution of the population of 25 to 64 years old, by highest level of education attained, table A.1.1 in the Statistical Annex. Magnitude for pre-primary and primary education is either negligible or zero for Denmark and Finland, and for post secondary non-tertiary education for Finland and Sweden. Data for Norway is from 2000.
[49] See table A.1.1

Table 1.2: Tertiary graduates, by field of study and level of education, 2000[50]

field of study	type	Denmark	Finland	Iceland	Norway	Sweden	OECD
Education	A	1	8,2	24,8	22,7	18,8	13,2
	B	19,2	0,3	6,4	a	4,9	13
Humanities and arts	A	23,6	12,4	13	7,2	5,7	12,6
	B	2,2	4,2	14	5,5	6,3	7,6
Social sciences, business	A	44,7	23,5	28,4	22,1	21,6	33,5
and law	B	7,9	22,1	47,5	51	14,6	25,8
Services	A	0,3	2,6	n	3,3	1	2,5
	B	5,4	16,9	n	5,2	14,3	9
Engineering,manufacturing	A	8,9	24	7,1	6,8	20,5	13,2
and construction	B	12,4	19,5	n	14,9	23,3	14,7
Agriculture	A	3,2	2,3	0,7	1,4	1	2,3
	B	1,1	1,5	n	0,1	7,1	2,4
Health and welfare	A	5,5	19,3	15,3	25,3	22,8	11,5
	B	49,2	31,5	n	1	8,9	18,8
Life sciences	A	4,2	1,9	4,9	1,2	2,3	3,1
	B	n	a	n	n	0,1	n
Physical sciences	A	4,3	2,7	2,1	1,4	2,4	3
	B	n	a	n	a	0,1	n
Mathematics and	A	1	1	0,5	0,3	0,6	1,1
statistics	B	n	a	n	a	0,2	n
Computing	A	1,8	2,2	3,3	3,3	3,1	3,1
	B	2,7	4	32,2	21,6	20,5	6,8
Not known or unspecified	A	n	n	a	4,9	n	0,9
	B	0,1	a	a	0,7	a	0,9

Source: OECD 2002: Education at a Glance

The table shows a similar distribution pattern of various disciplines and topics in all the Nordic countries. In all these countries the highest share of students at the tertiary level is in social sciences, business studies and the law. All countries also have a high score in health and welfare. In 2000 Sweden and Finland show a high proportion of graduates in engineering, manufacturing and construction, while Iceland, Norway and Sweden in computing, Denmark, Finland and Iceland in humanities and art and Finland and Sweden in services. All the Nordic countries show low scores in physical science plus mathematics and statistics.

The low scores in physical science and mathematics may lead to competence deficits in some high tech industries, which are why several of the Nordic countries have implemented programmes and measures aimed at making young people – and especially women – select such studies.

However, for an SME perspective the situation is far from bleak. Competences in the fields of social science, law, the humanities, health and welfare are also useful in the business sector, partly because these people have a general competence base that may be adapted to various purposes, and partly because most SMEs operate outside the high tech sector.

[50] Annotation a:Data not applicable because the category does not apply, n: magnitude is either negligible or zero.

Labour market
The labour market data presented below originate from the International Labour Organization (ILO). ILO derives the population into three parts: the employed and the unemployed constitute the labour force, and the third part is those outside the labour force. Those outside the labour force are, in addition to the retired and the disabled, young people in the educational system and those engaged in work without remuneration.

The employment rates presented in table 1.3 are calculated by the number of people in the labour force between the ages of 16 and 64.

Table 1.3: Employment rates in the labour market in 2001[51]

Employed, 2001			Unemployed, 2001	
Country	**in thousands**	**as a percentage**	**in thousands**	**as a percentage**
Denmark	2691	77	136	5
Finland	2350	68	238	9
Åland	13	78	0	2
Island	153	87	4	2
Norway	2236	78	83	4
Sweden	4239	75	175	4

Source: Nordic Statistical Yearbook 2002

Finland had the lowest employment rate and Iceland the highest in the Nordic area in 2001. Finland has the highest unemployment rate, 9.2 per cent, far above the unemployment rate in the other Nordic countries. In all the Nordic countries the unemployment rates have dropped since 1995. This also applies to Finland. The only exception is Sweden where figures first began to drop in 1998.

At the moment of writing it seems that unemployment rates are on the rise again, partly as result of the international economic development. From an innovation policy point of view it should be noted, however, that since the late 1990's the main problem for many Nordic companies has not been the high unemployment rate, but the fact that they find it hard to find experts with competences in specific areas. This has, in some respects, led to higher wages and higher costs for the companies involved.

Although it is hard to predict the future competence needs of industry as well as society, this clearly shows that education must be an integrated part of innovation policy development. By producing a sufficient number of candidates in particular disciplines and technologies, the authorities will help companies developing the competences needed for future innovation.

Industrial structure
The labour market structures of the Nordic countries have changed considerably over the recent decades. There has been a shift away from the agrarian and industrial sectors to the service sector and a large public sector. The number of employed in the

[51] Data are collected at national statistical institutes; data from Denmark, Finland, Iceland and Sweden are all collected as labour force survey data. Finland: annual average, data includes Åland. Åland: 2000 data. Sweden: the original data is published in hundreds.

agricultural sector is declining, while for all other sectors employment is rising, particularly within the sectors of finance, insurance, real estate and business services.[52]

Table 1.4 shows that this pattern is found in all the Nordic countries. Mining, manufacturing, electricity and water, however, still employ a larger part of the labour force in the Nordic countries than finance, insurance, real estate and business services. At the Faroe Islands agriculture, forestry, hunting and fishing are still important industries.

Table 1.4: Employed by industry in thousands and in percentage, 2001[53]

Industry	Denmark	Farao Is.	Finland	Åland	Iceland	Norway	Sweden
Total	2668	30	2350	13	153	2278	4239
In percentage of total	*100*	*100*	*100*	*100*	*100*	*100*	*100*
Agriculture, forestry, hunting and fishing	3	13	6	7	7	4	2
Mining, manufacturing, electricity and water	17	17	21	10	16	15	18
Construction	6	5	6	6	7	7	6
Wholesale, retail trade, restaurants and hotels	18	13	15	13	19	18	15
Transport and communication	7	8	7	19	6	7	7
Finance, insurance, real estate, business service	13	12	13	8	13	12	15
Services	35	31	32	32	32	38	37
Unknown	0	1	0	5	0	0	0

Source: Nordic Statistical Yearbook 2002

Moreover, the employment statistics hide the fact that fishery and aquaculture are important and profitable industries in the Icelandic and Norwegian economies. The fact that the number of employees is relatively low, does not mean that an industry is passé or on its way to the dung heap of history. It might just as well mean that the industry has succeeded in innovating, thus reducing production cost and the need for manpower.

Hence it is important to avoid oversimplified views of the historical and economical development of the Nordic countries. There are, for instance, valid arguments for the Finish investments in information and communication technologies, but that does not mean that the Finns should stop investing in their forestry industry. Traditional industries with a low employment rate, but with high profitability, may lead to the development of service industries serving this particular industrial cluster. Moreover, the surplus may also lead to thriving local communities with new companies serving the needs of the people.

Access to communication technology

The Nordic countries are in front as regards the implementation and use of information and communication technologies. Computers, the internet and mobile phones have

[52] Nordic Statistical Yearbook 2002

[53] Data are collected at national statistical institutes. Finland: labour force survey data, annual average. Finnish data includes Åland. Åland: 1999 data. Iceland: labour force survey data. Norway: employed includes people aged 16-74, annual average. Sweden: labour force survey data.

opened up new channels of communication. In the 1990s information and communication technology made its entry into a large share of Nordic homes.

Table 1.5: Access of individuals to communication technology at home in per cent in 2002[54]

Comm.tech.	Denmark	Finland	Iceland	Norway	Sweden
Computer	77	63	74	76	75
Internet	61	53	73	61	68
Mobile phone	80	94		93	89

Source: Nordic Information Society Statistics 2002; Nordic Statistical Yearbook 2002

The Nordic countries show, however, some differences regarding the profile of individuals' access to communication technology equipment at home. Finns have a lower degree of home access to computers and thereby to the Internet than people in the other Nordic countries. Iceland has the highest proportion of the population with Internet access at home[55].

Data indicates that around 90 per cent of the population in the Nordic countries have access to a mobile phone, with the exception of Denmark, where the figure is 80 percent. The mobile phone has become an expected tool in these countries.[56]

The high penetration of computers, the Internet and mobile phones is important from an innovation policy perspective. The fact that people see computers and mobile phones as an obvious part of their lives means that they know how to use this technology. This makes it easier for companies in any sector to make use of advanced ICT solutions in their production. An ICT savvy population is also a new market a market for Web services, Internet shopping, SMS services, ring tones etc. By using their own inhabitants as a testing ground, Nordic companies should be able to get a head start in the global markets.

Then of course, there is the fact that the Nordic countries have some of the major ICT companies in the world, Nokia and Ericsson included. These companies provide jobs and revenue in their own right, but also functions as customers and suppliers, thus becoming important nodes in the innovation system.

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[54] Data has been collected as a survey in Denmark, Finland and Sweden in 2002, data from Norway is from a media use survey in 2001 and Iceland from an Eurobarometer; Gallup Europe in 2001. Data for Iceland on access of individuals to computers is from Nordic Statistical Yearbook 2002. There is no available data for access of individuals to mobile phones in Iceland.

[55] However, although the table shows that 73 per cent of the Icelandic has access to the Internet, the Nordic Statistical Yearbook shows that 67 per cent has access to the Internet. Comparing the data from these two sources still indicates a similar pattern: Iceland has a high proportion of the population with access to the Internet at home, but Sweden ranks highest in the Nordic Statistical Yearbook.

[56] Compared to the access of a regular phone or computer, it can be argued that "access at home" has a different meaning in the case of mobile phones. A mobile phone is a personal communication invention implying that other persons in a home do not have access to it in the same way as an access to a home phone or computer. On the other hand the topic of the survey was 'access to', and one can also have access to mobile phones owned by other members of the households.

Quality of life, GDP, income levels and tax burden

The Nordic countries are among the richest nations in the world. Given that wealth of these proportions is dependent on a solid knowledge base, the countries are clearly doing something right.

The UN Development Programme publishes a so-called Human Development Index, which combines statistics on several indicators – adult literacy, average years of schooling, life expectancy and income levels – to give a better indicator of human development. It is far from perfect, but enlightening all the same.

Here is the ranking of the Nordic countries, compared to a few comparable nations:[57]

Rank	Country	Score
1	**Norway**	93.9
2	**Sweden**, Australia and Canada	93.6
5	Belgium	93.5
6	The US	93.4
7	**Iceland**	93.2
8	Netherlands	93.1
9	Japan	92.8
10	**Finland**	92.5
11	France, Luxembourg and Switzerland	92.4
14	United Kingdom	92.3
15	**Denmark**, Austria and Germany	92.1

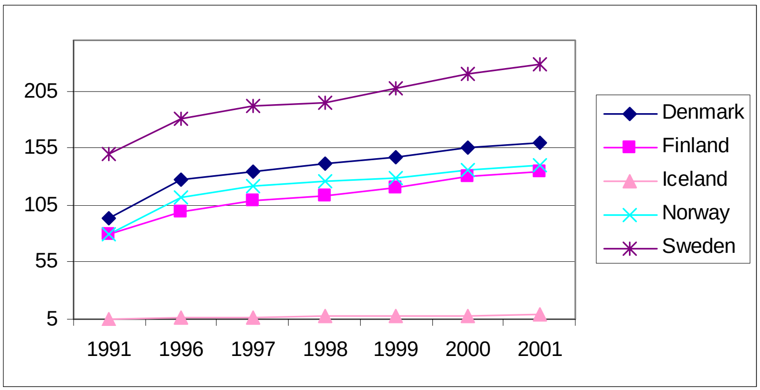
The gross domestic product (GDP) is a much used indicator in the comparison of capacity and efficiency of countries.

GDP is here presented as Purchasing Power Parity (PPP). A comparison of prices between countries can never be entirely correct because of the instability in exchange rates and differences in purchasing power. PPP is a method that tries to equalize price levels across countries. This method also present problems, but will nevertheless give a more correct picture of GDP development. In this report national currency data have been converted to US$ using PPP. The PPP are those developed by the OECD National Accounts Division updated for the most recent years by comparing the growth in prices in each country with that in the United States[58].

[57] *The Economist Pocket World in Figures 2003*, p.28. The index is scaled from 0 to 100. Countries scoring over 80 are considered to have high human development.

[58] For further details see sections III and IV of *National Accounts of OECD countries, Volume 1, 1989-2000,* OECD 2002 and *Purchasing Power Parities and Real Expenditures – 1999 Benchmark Year*, OECD 2002.

Figure 1.2: Gross Domestic Product, GDP in million current PPP$[59]



Source: OECD 2002/1: Main Science and Technology Indicators

Generally GDP is an unsuitable indicator for comparing nations, because GDP is a measure of total production. It does not take regional, social or industrial differences into consideration. Additionally, when comparing the Nordic countries it is important to bear in mind that the oil and gas revenues lead to a very high GDP in Norway. Nevertheless, due to similarities in the social and economic structure of the Nordic countries it is possible to use GDP as a background indicator in mapping innovation policy at national level[60].

The overall picture shows that the Nordic countries have a high GDP compared to other OECD countries. When comparing the Nordic countries there are only small differences in disposable income. Sweden, Finland and Denmark show lower disposable income level per capita than Iceland and Norway.

Table 1.7: Disposable income per capita at current PPP$s, 2000[61]

	Denmark	Finland	Iceland	Norway	Sweden	OECD[62]
Disposable income per capita	15468	14951	17120	18728	13851	14590

Source: OECD 2002: Main Economic Indicators

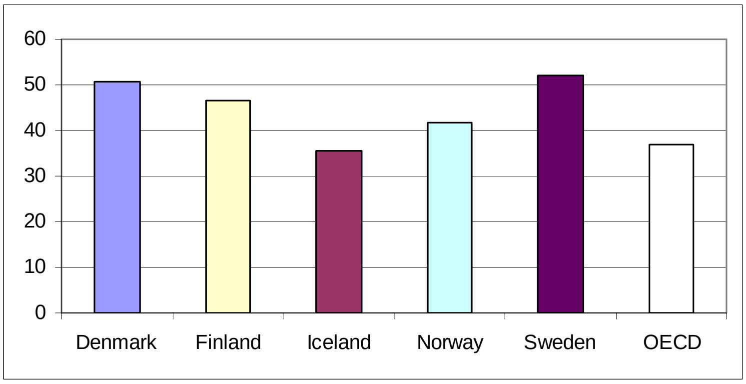
On average Nordic salaries are higher than in many other OECD countries, leading to higher costs for companies. However, in general people with higher education have relatively lower wages than competing economies, which should give many Nordic companies a competitive advantage. If well educated labour is "cheap", it should be easier for these companies to hire the kind of people that can contribute to more advanced learning and innovation processes.

The tax burden of the Nordic countries is relatively high. To a certain degree the Nordic welfare model, in which many services are financed by general taxes, especially social security and welfare services, is reflected in the level of taxes. However, this tax burden

[59] See table A.1.2
[60] The statistic presented from OECD in this report uses a GDP deflator from the OECD National Accounts database updated for the most recent years by Secretariat projections of changes in the GDP deflator, published in *OECD Economic Outlook*, except in the case of Norway where a deflator excluding trends in petroleum prices has been used.
[61] Data for Finland is for 2001
[62] This is not an official OECD average, but an estimate made by the authors.

must be compared with the services given to companies, both directly as government support to companies (innovation policy measures, grants etc.) and indirectly as social services provided to their employees and their local communities.

Figure 1.3: Total tax revenue as percentage of GDP,1999[63]



Source: OECD 2002: Trends in Tax Burdens and Tax Structures

Resources for research and development

Traditionally research and development (R&D) has been considered the most important source of innovation. Some even interpret the word "innovation" to mean "R&D". As noted elsewhere in the GoodNIP reports, R&D is not the only way of innovating. Companies innovate by small incremental improvements of products, processes and services. They innovate by acquiring and implementing new tools and new machinery, and they innovate by gaining new knowledge from suppliers, customers and various partners. In many industries R&D is not the major means of innovation, nor should it be. For many companies it makes perfectly sense to focus their efforts on organisational change, design, branding or marketing.

That being said, R&D is important. In many industries companies have to invest in R&D to survive. Moreover, they have to perform their own research, not only in order to create new inventions, but also because the R&D process is a learning activity. The employees gain important knowledge through the research process, competences that can be used beyond the concrete research project itself.

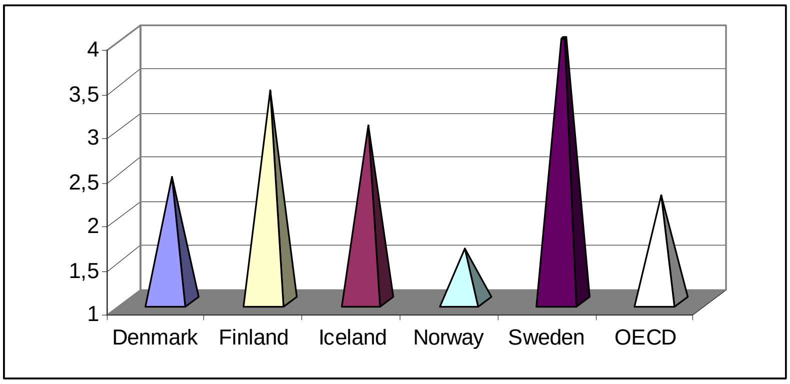
R&D is also important in the innovation system as a whole. Even companies that do not do their own research will make use of R&D based machinery, technology or knowledge, and the country needs research environments that are able to find, understand and make use of science and technology developed elsewhere. That is: Nordic industry need knowledge institutions that can function as bridges to the international scene. These knowledge institutions may be large, R&D intensive companies, universities and colleges or institutes and laboratories. Hence although companies may innovate without investing in R&D, the innovation system as a whole cannot.

[63] See table A.1.3. Data for 1999 are provisional; data for OECD total is from 1998.

The investments in research and development (R&D) have increased considerably in all OECD-countries during the last decade. The Nordic countries show a quite similar R&D tendency, although there are some differences.[64]

GERD as a percentage of GDP and per capita
Gross Domestic Expenditure on R&D (GERD) is the standard expenditure measure covering all R&D activities carried out on national territory in the year concerned.

Figure 2.1: Gross Domestic Expenditure on R&D (GERD) as percentage of GDP, 2001[65]



Source: NIFU 2003; OECD 2002/1: Main Science and Technology Indicators

Finland and Sweden show the highest levels of total capital investment in R&D as a percentage of GDP, and Norway the lowest. However, it can be argued that the GERD as a percentage of GDP is a difficult indicator to use in that it does not take into account differences in the sizes of GDP nor the different industrial structure of countries.

As pointed out above Norway has a very high GDP due to oil revenues. This affects the GERD as percentage of GDP negatively. Norway does, however, also rate lower than the other Nordic countries as regards GERD per capita (see figure 2.2), which clearly

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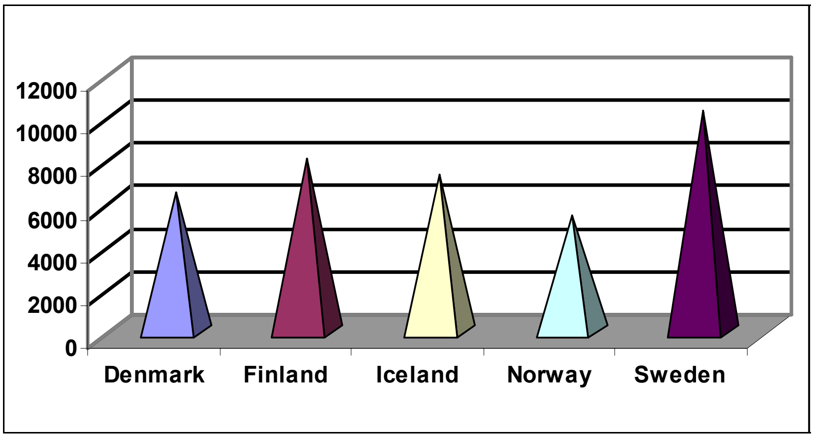
[64] The data presented here from OECD *Main Science and Technology Indicators* reports for 2000, 2001 and 2002 have been collected and presented in line with the standard OECD methodology for R&D statistics. See: *The Measurement of Scientific and Technological Activities: Proposed Standard Practice for Surveys of Research and Experimental Development – Frascati Manual 1993 (OECD).* Most R&D data are derived from retrospective surveys of the units actually carrying out or “performing” R&D projects. The indicators presented, except for GBAORD and the patent-data, are based on the sum of performers’ reports of their R&D expenditure and personnel on national territory (i.e. excluding payments to international organisations and other performers abroad).The indicators on GBAORD and patens are based on R&D reported by the funding ministry or agency and include payments to international organisations and other performers abroad. The specification of these two sets of R&D data varies significantly and the two types of data should not be combined. Some detailed national specifications may vary, though all OECD countries generally collect and report R&D in line with the “Frascati Manual”. These differences are generally too small to affect the general indicators. The Secretariat has made a number of estimates to fill gaps and to bring series up to date; by using simple statistical routines or information from national publications and observations of trends. Data points where such estimates exceed 25 % of the zone total have been suppressed. The zone totals for GBAORD data are however essentially arithmetic totals of the available national data, because of the difficulty in forecasting R&D budgets.

[65] See table A.2.1 in the Statistical Annex. Finland and Iceland are estimates. Data for OECD is from 1999 and is a secretariat estimate or projection based on national sources.

indicates that Norway does indeed invest less in R&D than Denmark, Finland and Sweden.

Figure 2.2: Gross Domestic Expenditure on R&D (GERD) per capita in NOK, 2001[66]



Source: NIFU 2003

When comparing expenditure on R&D as a percentage of GDP from 1991 to 2001 we find that the percentages have gradually increased in all the Nordic countries (table 2.1). The only exception is Norway where the expenditure on R&D as a percentage of GDP has been stable, and has even declined – as it did from 1999 to 2001.

Table 2.1: GERD as a percentage of GDP 1991-2001[67]

Country	1991	1993	1995	1997	1999	2001
Denmark	1,64	1,74	1,84	1,94	2,09	2,43
Finland	2,04	2,17	2,29	2,72	3,22	3,4
Iceland	1,17	1,35	1,56	1,86	2,37	3,01
Norway	1,64	1,82	1,7	1,64	1,65	1,62
Sweden	2,79	3,27	3,46	3,67	3,78	4,28

Source: NIFU 2003

In Iceland and in Sweden, the increase in R&D investments shows significant “jumps” upwards. This may be explained by considerable increases in some few business enterprises focus on R&D in 2001; the biotech company deCODE genetics in Iceland and Ericsson and ABB in Sweden. Correspondingly, preliminary data for 2002, shows a considerably decline in GERD as a percentage of GDP in Sweden by probably as much as one percentage point. This is mainly due to reduced R&D investments by these particular companies[68]. This is a clear illustration of the liability of these data. In Iceland, Finland and Sweden there are a few high tech companies that alone may change the national level of R&D investments.

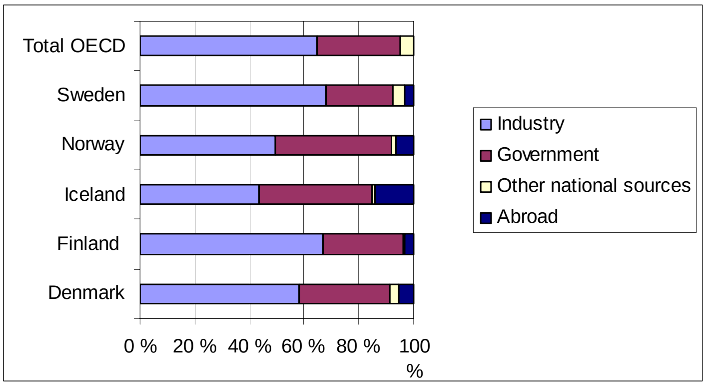
Countries like Denmark and especially Norway are not to the same extent dependent on one or two R&D intensive companies to ensure high R&D investments levels, but then again this also means that general R&D expenditure is lower. Especially Norway has an

[66] Data is given in Norwegian crowns, 1 EURO=7,8 NOK (exchange rate at 10.04.2003). See table A.2.1 in the Statistical Annex, where also GERD per capita in PPP$ for 1999 is given.
[67] Estimates for Iceland and Finland for 2001.
[68] Unpublished data from Vinnova.

industrial structure dominated by small companies in industries that do not invest much in R&D regardless of where they are situated in the world.

GERD per source of finance and performing sector
R&D expenditures are normally divided into five sources of finance; industry or business enterprises, public government funding, the higher education sector, private non-profit institutions and funding from abroad. The funding from the sector for higher education and private non-profit institutions is very small and has been combined as "other national sources" in figure 2.3.

Figure 2.3: Percentage of GERD per source of finance, 1999[69]



Source: OECD 2002/1: Main Science and Technology Indicators

R&D is mainly funded by national sources in the Nordic countries. In Iceland however, as much as 14 per cent of R&D is financed by foreign sources.

Industry is the main financial contributor in Sweden, Finland and to a less degree in Denmark and Norway. The government is the main source on Iceland.

Domestic R&D measures as expenditure and personnel, is divided into three sectors of performance: industry or business enterprises, the sector of higher education and the government sector.[70]

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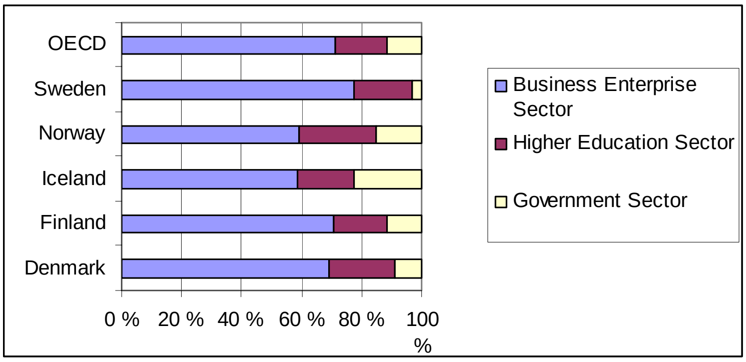
[69] See table A.2.2 in the Statistical Annex. Denmark: the sum of the breakdown does not add to the total. Finland: Private-non profit institutions are included in the Government sector in non-survey years, and higher education sector includes central university hospitals. Sweden: funding from the Public Research Foundations were classified as funding from the private non-profit sector until 1997, after considered as funding from the government sector. OECD: secretariat estimate or projection based on national sources and data is not included for percentage of GERD financed abroad.
[70] OECD also operates with a fourth category: private non-profit organisations (i.e. charity and voluntary organisations). Percentage of GERD performed by this sector in the Nordic countries is however low, see table A.2.3

Figure 2.4: Percentage of GERD performed by sector, 2001[71]



Source: NIFU 2003; OECD 2002/1: Main Science and Technology Indicators

In all the Nordic countries the major sector for R&D performance is the business enterprise sector. The higher education sector appears as the second most important sector for R&D activities, except in Iceland where the government sector perform a more significant part.

It should be noted though, that Norway has a different institutional structure for R&D than the other Nordic countries. In Norway the research institute sector performs one fourth of the total R&D activities[72]. "Research Institutes" is a generic term of R&D performing institutions primary serving industry, the public sector and non-profit associations[73].

Researchers and R&D personnel

Resources can also be measured in terms of the total numbers of researchers[74] and R&D personnel devoted to research and development activities (figure 2.5). Personnel data are expressed in full-time equivalents (FTE) on R&D, a person working half-time on R&D activities is counted as 0.5 person years.

Researchers are traditionally responsible for the knowledge production in the R&D process and the exploitation of the results, but other knowledge workers in management, production and services are also considered to be of growing importance. If you add the researchers and this additional group, you get what statisticians call "total R&D personnel".

However, given that a large number of companies do not perform their own research, but innovates all the same, it is clear that counting the number of researchers of R&D personnel give you only part of the innovation policy picture.[75]

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[71] See table A.2.3 in the Statistical Annex. Norway: R&D performed by research institutes directed against the industry is involved in the business enterprise sector. Sweden: private non-profit institutions included in the Government sector. OECD: data is from 1999 and is a secretariat estimate or projection based on national sources, data originally includes private-non-profit sector.

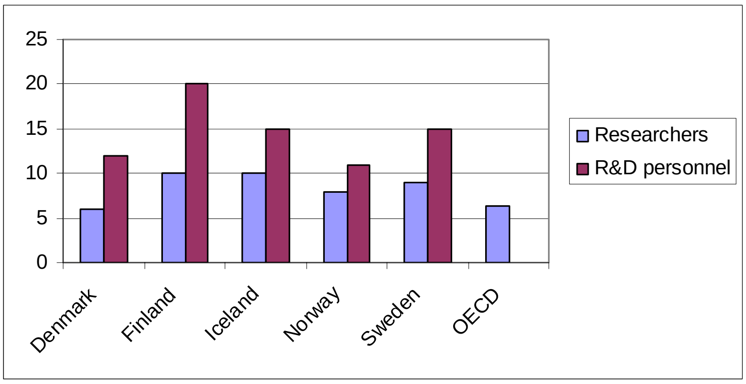
[72] Norges forskningsråd 2001

[73] For further reading: Wiig og Mathisen 1994; Brofoss 1996; Norges forskningsråd 2001

[74] Research scientists and engineers include the occupational groups ISCO-2 (Professional Occupations) and ISCO-1237 (Research and Development Department Managers). See the Frascati Manual (OECD 1993).

[75] European Commission 2002: *Towards a European Research Area. Science, technology and innovation, Key Figures 2002.*

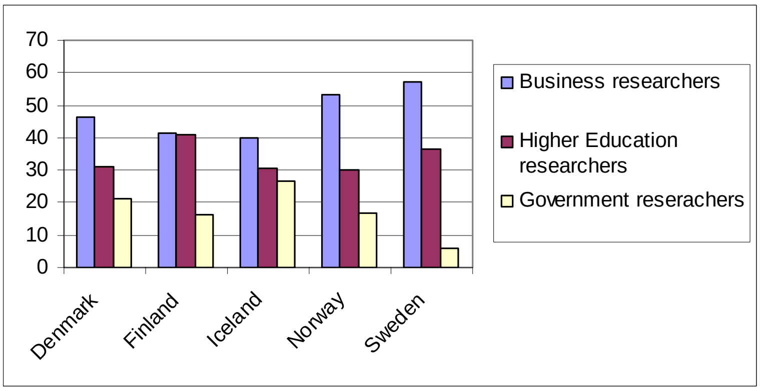
Figure 2.5: Researchers and R&D personnel per thousand total employment, 1999[76]



Source: OECD 2001/2: Main Science and Technology Indicators

The total numbers of researchers in all the Nordic countries are around 10 FTE per thousand employees, except for Denmark, which reports six researchers per thousand totally employed, equalling the OECD average. Finland shows a high proportion of higher education researchers as a percentage of national total, and Iceland a high proportion of government R&D personnel.

Figure 2.6: Researchers distributed at the Business Enterprise, Higher Education and Government sector, as a percentage of national total, 1999[77]



Source: OECD 2002/1: Main Science and Technology Indicators

The numbers of business enterprise R&D personnel as a percentage of national totals are, quite high for all the Nordic countries. One interpretation is therefore that the business enterprise sector is the main employer for R&D personnel in the Nordic countries. The numbers indicate that this is particularly so in Sweden, and to a lesser degree in Iceland. This fits the numbers for performing sectors above.

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[76] See table A.2.4 in the Statistical Annex. Sweden: the national totals of R&D personnel and researchers are underestimated as data for the private non-profit sector are missing. OECD: secretariat estimate or projection based on national sources, data not available for R&D personnel.

[77] See table A.2.5 in the Statistical Annex. Data for Norway on government researchers includes other classes: R&D performed by private non-profit institutions.

Table 2.2: R&D personnel in Business Enterprise, Higher Education and Government, 1999[78]

Countr y	Business Enterprise R&D personnel (FTE)	Business Enterprise R & D personnel as a percentage of national total	Business Enterprise R & D per thousand employment in industry	Higher Education R&D personnel (FTE)	Government R&D personnel (FTE)
Denmar	21022	59	12	8017	6236
Finland	27818	55	17	14840	7454
Iceland	961	40		712	645
Norway	13308	52	10	7313	4779
Sweden	44171	66	18	19175	3195

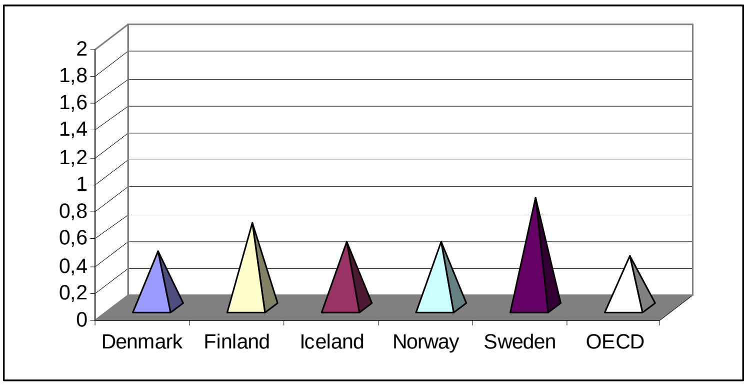
Source: OECD 2002/1: Main Science and Technology Indicators

HERD

The Higher Education Sector has had an increasing importance for the R&D in the Nordic countries in the 1990s.[79] The Higher Education Sector performed one fifth of GERD in the Nordic countries in 1999 (see figure 2.4).

The share of total Higher Education R&D (HERD) carried out in 1999 still amount to a small percentage of GDP in all the Nordic countries (figure 2.7).

Figure 2.7: Higher Education Expenditure on R&D, HERD, as a percentage of GDP, 1999 [80]



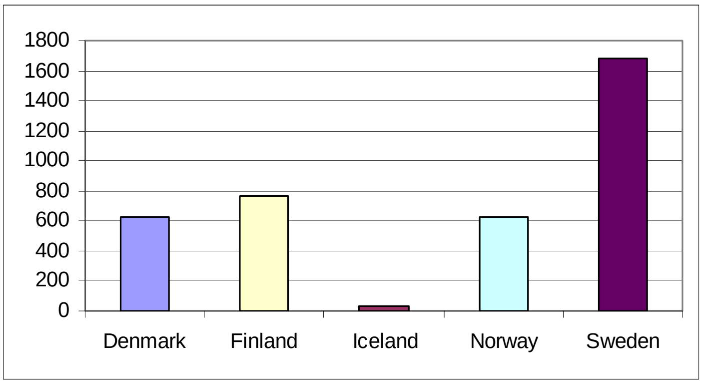
Source: OECD 2002/1: Main Science and Technology Indicators

However, all the Nordic countries are above the average in OECD. Among the Nordic countries there are small differences in HERD as a percentage of GDP. Denmark, Iceland and Norway have an almost equal proportion, Finland somewhat higher, while the percentage of Sweden is by far the highest.

[78] Data is not included for business enterprise R&D personnel per thousand employed in industry in Iceland, data for Norway on government R&D personnel includes R&D performed by private non-profit institutions.
[79] OECD 2002/1: Main Science and Technology Indicators; Nordic Statistical Yearbook 2002
[80] See table A.2.6 in the Statistical Annex. The data is underestimated as all R&D carried out in hospital departments at the university-hospitals is included in the Government sector. Data for total OECD is secretariat estimate or projection based on national sources

Calculated in million current PPP$, the spending on HERD is almost equal in Denmark, Finland and Norway. Sweden shows the highest spending also here.

Figure 2.8: Higher Education Expenditure on R&D, HERD, in million current PPP$ 1999[81]



Source: OECD 2002/1: Main Science and Technology Indicators

As shown in figure 2.3 a very small amount of GERD is financed by the Higher Education sector in the Nordic countries. Industry and government are the main financial sources of R&D in the Nordic countries.

In 1999 industry financed only a small part of HERD in the Nordic countries. Government remains the main supplier of R&D funds in this sector.

Table 2.3: Percentage of HERD financed by industry, 1999[82]

Country	**1999**
Denmark	2,1
Finland	4,7
Iceland	9,2
Norway	5,1
Sweden	3,9
OECD	6,1

Source: OECD 2002/1: Main Science and Technology Indicators

However, between the Nordic countries there are noticeable differences as to whether industry finances HERD. In Iceland 9.2 percentage of HERD is financed by industry, while in Denmark only 2.1. According to the OECD average, industry finance less HERD in the Nordic countries than what is the average in the OECD area.

Public expenditure on education

There is no available data on how the expenditure on R&D is distributed in the Higher Education Sector in the Nordic countries. Total public expenditures on education in the Nordic countries are presented in table 5.1. These numbers give some indication as regards the Governments' role in the education sector as a whole.

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[81] See table A.2.6 in the Statistical Annex and methodological comments under footnote 39.

[82] Data for Denmark: the sum of the breakdown does not add to the total. OECD: secretariat estimate or projection based on national sources.

Table 2.4: Total public expenditure on education, 1999[83]

	Public expenditure on education as a percentage of total public expenditure			***Public expenditure on education as a percentage of GDP***		
	Primary, secondary and post-secondary non-tertiary education	**Tertiary education**	**All levels of education combined**	**Primary, secondary and post-secondary non-tertiary education**	**Tertiary education**	**All levels of education combined**
Denmark	8,7	4,3	14,9	4,8	2,4	8,1
Finland	7,6	4,2	12,5	3,8	2,1	6,2
Norway	9	4,2	15,6	4,3	2	7,4
Sweden	8,9	3,7	13,6	5,1	2,1	7,7
OECD	8,7	2,8	12,7	3,5	1,2	5,25,2

OECD 2002: Education at a Glance

Regarding all levels of education combined, the Nordic countries have a quite similar public expenditure as a percentage of total public expenditure on education and as a percentage of GDP. Finland shows, however, some lower score than the other countries. There are almost no differences between the Nordic countries' public expenditure on primary, secondary and post-secondary non-tertiary education as well as tertiary education. Denmark, Finland, Norway and Sweden all show a higher proportion of public expenditure on primary, secondary and post-secondary education than tertiary education.

The Nordic countries have invested heavily in education, and especially higher education. Needless to say, these investments will have effect on the innovative capabilities of firms, basically because innovation is based on learning, and the companies' ability to learn rests on the "absorptive capacity" of their employees. Although "learning by doing" – i.e. practical work experience – is the most targeted form of learning in industry, the educational foundation is nonetheless very important. At school and in universities and colleges students learn the basic tenets of their trade, fundamental scientific and technological principles as well as relevant "facts". Moreover, they learn the tools of the trade; they learn how to learn, for instance by doing their own research.

The research performed at the universities must be understood within this framework. University and college research has two objectives: To lay the foundation for advanced student learning and to contribute to the general advancement of knowledge in society. Both are important from an innovation policy view.

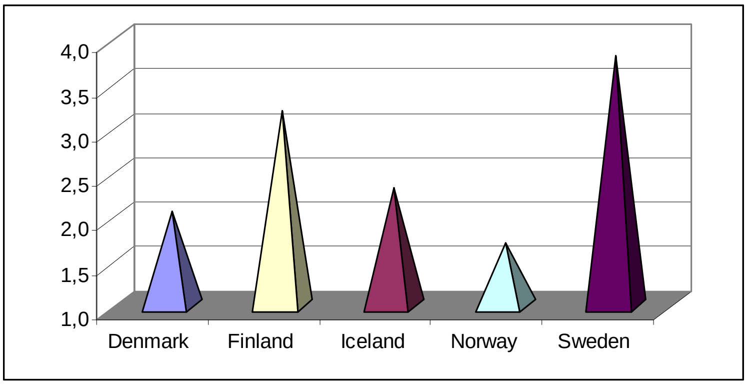
[83] The education system is classified after ISCED (see chapter 1). The Public expenditure presented in this table includes public subsidies to households for living cost – which include subsidies for living costs and other private entities – as a percentage of GDP and as a percentage of total public expenditure, by level of education and year. Data is not available for Iceland.

GBAORD or government investments in R&D
Government budget appropriations or outlays for R&D (GBAORD) is one way of measuring government support to R&D activities – indicating how much priority Governments give to publicly funding R&D activities.

The data on Government budget outlays on R&D are collected by national authorities using budgets statistics. This essentially involves identifying all the budget items involving R&D and measuring or estimating their R&D content. The estimates are based on reports by the funding ministry, generally covering federal or central government only. These data are therefore less accurate than "performer-reported" data. On the other hand, as they are derived from the budget they can be linked back to policy issues by a classification of "objectives" or "goals".

The classification used is one specially developed at OECD for R&D analysis, and is compatible with similar classifications used by the EC and by the Nordic countries.[84]

Figure 2.9: Government Budget Appropriations or Outlays for R&D (GBAORD) as a percentage of GDP, 1999[85]



Source: Nordic Statistical Yearbook 2002

Calculated as a percentage of GDP the government in Sweden spent most on R&D in the Nordic countries in 1999, the government in Norway spent the least.

However, total government budget appropriations or outlay on R&D shows that Norway spent almost as much as Denmark in 1999 and 2001, and that the country is not too far behind as regards government support to R&D as the GBAORD as a percentage of GDP figures indicate. On the other hand, from 1999 to 2001 there was a decline in both Norway and Iceland.

[84] The assembling of budget items result in an allocation of socio-economic objectives on the basis of intentions at the time the funds are committed and not the actual content of the projects concerned. These breakdowns reflect policies at a given moment in time. For further details see: *Main Science and Technology Indicators* OECD 2002
[85] See table A.2.7 in the Statistical Annex.

Table 2.5: Total Government Budget Appropriations or Outlays for R&D (GBAORD) in million current PPP$[86]

Country	1999	2001
Denmark	1067	1143
Finland	1280	1342
Iceland	101	85
Norway	980	950
Sweden	1576	2018

Source: OECD 2002/1: Main Science and Technology Indicators

Given that all the Nordic countries aim at increasing their total R&D investments, all these governments encourage industry to invest more in R&D. This certainly makes sense, as industrial R&D investments not only affect the companies directly involved, but also other companies by various spill-over mechanisms. A product invented by one company may, for instance, lead to increased productivity among its customers. The competences developed by one company may enrich others by means of technology co-operation, human mobility etc. As a matter of fact, market near R&D of this kind can also benefit university research, which may make use of technology or methods invented in the private sector.

However, one should be careful not to think of R&D as one unified concept. Company R&D cannot normally replace university research. They are of different kinds. Company R&D is often short term and market oriented. University research is on the other hand supposed to have a more long term horizon. Terms like “researcher driven” or “curiosity driven” have been used. An important objective for this research is to interact with the educational responsibilities of these institutions. Students need a broad basic training that go beyond the immediate market-driven needs of a company, partly because of the need to acquire a fundamental understanding of scientific and technological principles, and partly because the technological reality may have changed by the time the students reach “the real world”.

This is important, because a more superfluous reading of these statistics may imply that a country that invests relatively much in R&D need not worry about national R&D investments. Actually, there could be a serious systematic instability if these investments are dominated by one form of R&D, whether this form is defined by a discipline, branch of industry or institutional type.

The Finns have invested heavily in R&D in the field of information- and communication technologies. This may indeed have been a sensible choice, given the country’s need for new industries and new markets after the fall of the Soviet Union, and no one can argue with success. However, Finland’s “knowledge economy” has also become very vulnerable. If Nokia experiences the same fate as Ericsson the Finish

[86] Data for Denmark in 2000 and 2001 are a break in series with previous year for which data is available because the method of assessing GBAORD changed; in 2000 GBAORD was changed to include provincial funding of R&D in hospitals and funds from the Danish National Research Foundation and the VaekstFonden. Finland: funding from external sources of the State research institutes are excluded from Government appropriations, data covers central university hospitals. Data for Iceland in 2000 and 2001 and for Norway in 2001 are provisional. Funding from the Public Research Foundations is excluded from the GBAORD data.

R&D adventure will suffer a momentous backlash. Hence it makes sense for them to diversify.

The Swedes have focused their public R&D activities in their university/college sector. This also makes sense, as it easier to integrate basic and applied research in this way. There is a problem, though. The universities have overreaching objectives that go beyond industrial development. This is reflected in a culture that has to reward scholarly achievements more than on-time innovation and market orientation. This makes it difficult for at least some of these milieus to co-operate with companies, and especially SMEs. This strong focus on university research and technological development also means that Sweden may underestimate the need for other forms of innovation.

The Norwegians have, on the other hand, developed a large sector of market oriented institutes for applied research, institutes that more easily can function as bridges between basic science and industry. These institutions may also more easily understand how to integrate R&D activities into other forms for innovation. The fact that such a sector exists, means that the Norwegian authorities need not to the same extent as other countries encourage university/industry relationships. By making the universities more like the institutes, Norway may actually risk weakening the unique quality of the universities, while at the same time undermining the competitiveness of the institute sector.

One general observation is that the innovation system must be understood as a whole. In many branches of industry companies actually do not have to perform their own R&D or invest in R&D in order to innovate. However, they must have access to companies and institutions that know where to find, understand and make use of new R&D based technologies. In some areas large R&D intensive companies may become such "competence-nodes" in the systems, serving smaller companies through supplier-customer relationships. This observation can be used as an argument for support of not only small and medium sized companies, but also larger companies, if needed.

In other areas public institutions will have to take this role. If an economy lacks R&D intensive industries and companies, it would make sense for the government to compensate for this lack of R&D investments. However, this must primarily be research of direct relevance to the companies in questions.

Norway, and to a certain extent also Iceland and Denmark, lack the large industrial locomotives of the Swedes and the Finns. This can be used as an argument for increasing the public investments in R&D significantly. However, if the main objective of this expenditure is to compensate for small industrial investments, this research must be of direct relevance to the companies in question.

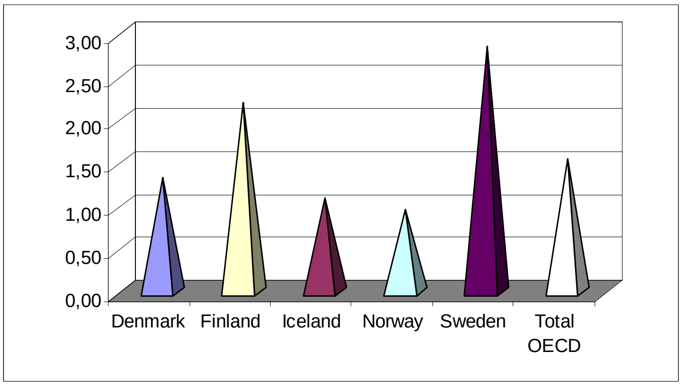
Another way of increasing the total expenditure on R&D in these countries is to develop a policy aiming at changing the overall industrial structure, i.e. replacing low tech with high tech R&D intensive industries. However, by doing this one risks making R&D the overall policy objective and not sustainable development or increased welfare. As long as industries are profitable and provide work and taxes, we see no reason for transferring these resources to new types of enterprises, provided, of course, that government take care to support the general development of competences in the country.

Innovation in industry

Information on R&D performed in the Business Enterprise sector covers private and public enterprises R&D activity, and R&D related activity purchased from institutes performing such activity.

BERD, business enterprise investments in R&D
Figure 3.1 presents the total Business Enterprise R&D (BERD) as a percentage of GDP in the Nordic countries.

Figure 3.1: Business Enterprise Expenditure on R&D, BERD, as a percentage of GDP, 1999[87]

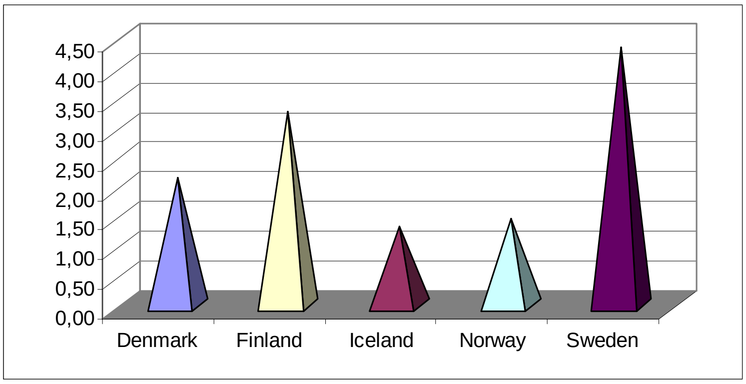


Source: OECD 2002/1: Main Science and Technology Indicators

Sweden shows the highest BERD as a percentage of GDP of the Nordic countries, and has as Finland also a higher BERD as a percentage of GDP than the OECD average. Denmark is found right under the OECD average, while Iceland and Norway has a quite low BERD as a percentage of GDP. The pattern is repeated when BERD is calculated as a percentage of value added in industry (figure 3.2).

[87] See table A.3.1 in the Statistical Annex. Data for Sweden is underestimated or based on underestimated data; full coverage of SMEs might add about seven percentage points to BERD. OECD: secretariat estimate or projection based on national sources and data is missing for BERD as a percentage of value added in industry.

Figure 3.2: Business Enterprise Expenditure on R&D, BERD, as a percentage of value added in industry, 1999[88]



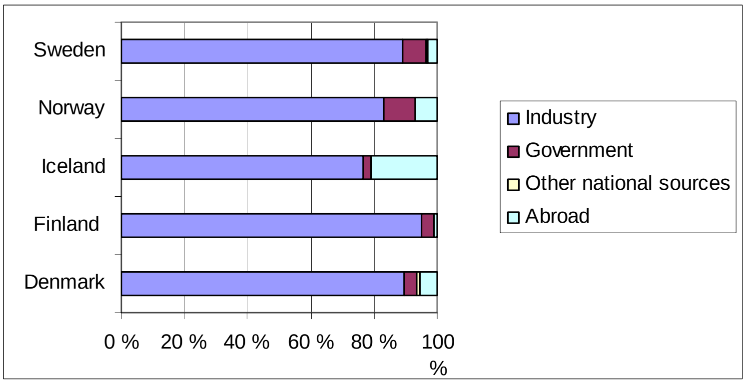
Source: OECD 2002/1: Main Science and Technology Indicators

As noted above, these differences are mainly caused by the fact that Sweden and Finland have more large, high tech companies, i.e. companies that by definition invest much in R&D. Iceland, Norway and to a certain extent Denmark have economies dominated by branches of industry that are less inclined to invest in R&D.

In the Nordic countries R&D in the Business Enterprise sector is mainly financed by Industry itself (figure 3.3). In Sweden the Government finance 8 per cent of Business Enterprise R&D, in Norway 10 per cent and in Iceland only 2 per cent. In Iceland, however, as much as 21 per cent is financed from abroad, while in Finland and Sweden almost no R&D is financed from abroad.

The Higher Education sector and Private Non-profit institutions are not financing R&D in the Business sector in the Nordic countries.

Figure 3.3: Percentage of BERD per source of finance, 1999[89]



Source: OECD 2002/1: Main Science and Technology Indicators

Number of innovators
Eurostat[90] indicate that relatively few enterprises in the European Union are able to build on innovative products, services and processes in order to remain competitive, gain new market shares and become major actors in the marketplace.

[88] See table A.3.1 in the Statistical Annex, and methodological comments under footnote 26.
[89] See table A.3.2 in the Statistical Annex.

It should be noted that Eurostat has registered the number of innovative enterprises and not the number of innovations. Innovative enterprises are here those enterprises that have successfully implemented a new product, process or service new to the firm, but not necessarily new to the enterprise's market, the country or the world.

The very act that defines an enterprise as an innovator is therefore the launch of a product or service that is different from those previously offered by the enterprise, or the introduction of a new or modified production process.

It can be argued that these statistics show innovation activity based on a traditionally view of innovation as a linear process; from an idea originating in specialized R&D departments carried through commercial exploitation, production, marketing and sales. Innovation is rather a complex activity involving all parts of firms *and* other actors in society in a reciprocal interaction, i.e. as a systemic process. However, this complexity generates a general problem in measuring innovation.

[90] Eurostat (2001): *Statistics on Innovation in Europe. Data 1996-1997.* Data are collected through the second Community Innovation Survey (CIS2). CIS is a coordinated action of the European Commission, the OECD and EEA Member States designed to obtain information on technological innovation. The first CIS were developed between 1991 and 1993, and was jointly initiated and implemented by Eurostat and the Innovation Programme (now under Enterprise DG). The survey aims at facilitating the accurate measurement of innovation activities at the enterprise level. Based on the experience gained during the first CIS, Eurostat, Enterprise DG and EEA Member States decided to launch a second round: CIS2 in 1997-1998. All the participants agreed on a common set of methodology on a pan-European scale; based on a revised version of the Eurostat/OECD Proposed guidelines for collecting and interpreting technological innovation data: the 'Oslo manual'. The statistical unit in CIS2 is the enterprise. The breakdowns between different economic activities are following the structure of European nomenclature of economic activities (NACE). Data for Iceland are not included in the Eurostat statistic, but are included from Statistic Island in the research report *Science and Technology Indicators for the Nordic countries.*

Table 3.1: Number of innovative enterprises in percentage, 1994-1996

		Denmark	Finland	Iceland	Norway	Sweden	CIS2
	Manufacturing sector	**71**	**36**	**34**	**48**	**54**	**51**
NACE	*Manufacturing sector, classified by line of business*						
15-16	Food, beverages and tobacco	73	25	29	47	38	50
17-19	Textile and leather	55	37	25	45	45	35
20-22	Wood, pulp and paper, publishing and printing	70	30	26	36	45	45
23-24	Coke, nuclear fuel, chemicals and man-made fibres	93	61	40	76	61	70
25-26	Rubber and plastics, other non-metallic mineral products	63	44	50	54	57	51
27-28	Basic metals and fabricated metal products	58	31	35	43	41	48
29-	Machinery and equipment	80	41	83	64	73	68
30-33	Electrical and optical equipment	88	51	66	65	75	69
34-35	Transport equipment	85	36	30	44	58	56
36-37	Manufacturing etc.	60	22	33	51	59	48
40-41	Electricity, gas, water supply	48	19	50	24	23	35
	Service sector	**30**	**24**	**38**	**22**	**32**	**40**
NACE	*Service sector, classified by line of business*						
51-	Wholesale, trade and commission trade	27	15	28	18	29	34
60-62	Transport	13	16	13	5	19	24
642-	Telecommunications	100	79	100	56	51	65
65-67	Financial intermediation	48	28	56	44	56	54
72-	Computer and related activities	89	63	69	50	55	68
742-	Engineering services	36	31	56	38	47	55

Source: TemaNord 2001

The CIS-results are based on answers from more than 37 000 enterprises (Icelandic results not included). The response rates vary from 24% to over 90%. The Danish response rate is very low, only 28%, and the Danish estimates are therefore very uncertain. Conclusions concerning the Danish figures should therefore be drawn with caution.

According to table 3.1 Denmark has a much larger share of innovating enterprises in the manufacturing sector than the other Nordic countries (although this may be due to a statistical fluke). Finland and Iceland have the lowest share, while Norway and Sweden is on the CIS average. In all the Nordic countries the numbers of innovators are lower in the service sector than in the manufacturing industry. In Denmark and in Norway the proportion is more than two times higher in the manufacturing sector than in the service sector.

However, as also Eurostat[91] comments, it would be misleading to conclude that the service sector is not innovative. In general, there are problems in measuring innovative

[91] *Statistics on Innovation in Europe, data 1996-1997, Eurostat theme 9 Science and Technology.*

activity in firms in the service sector, because innovative activity are most often not singled out in separate R&D divisions. Rather, innovation takes place in many different parts of the organization, developing product, process, organization and market innovations either incrementally or by recombination. Innovative activities are in fact to a large extent conducted in these parts, but the term "R&D" is not normally used for these activities. Innovation in the service sector is therefore underreported.[92]

All the Nordic countries show innovation activity in the category covering coke, nuclear fuel, chemicals and man-made fibres, the category containing machinery and equipment, the class containing electrical and optical equipment, the telecommunication category as well as in computers and related activities.

The table also shows variations between the Nordic countries. In Denmark, and to a lesser degree in Sweden, the share of innovating enterprises is high in all industries. In Finland only coke and chemicals is distinguished noticeably from the other industries. In Iceland the machinery and equipment sector and in Norway the firms categorized under "coke, nuclear fuel, chemicals and man-made fibres" are particularly innovative.

The number of innovators (i.e. innovative companies) is a basic indicator of the innovation activity in a sector. This statistic provides a general idea of the propensity to innovate, but fails to measure the complexity of the innovation process. The question "how many have been innovating" is answered unsatisfactory, because the statistic does not say anything about the intensity or the quality of the innovations. Particularly, it does not indicate whether the innovations are minor adjustments, substantial improvements or completely new revolutionary products. Especially, this is a problem in measuring innovative activity in the service sector. Services are not that standardized as manufacturing products. It is therefore more difficult to judge whether the service product is new or just an adaptation to fit the need of one customer.

In addition, the innovative enterprises can either introduce a new or substantially improved product or process on the market. Table 3.2 shows number of product and process innovators as a percentage of enterprises in the manufacturing sector.

Table 3.2: Number of product or process innovators as a percentage of enterprises in manufacturing sector, 1996[93]

Country	All innovators	Product innovator	Process innovator	Product innovator only	Process innovator only
Denmark	71	58	51	19	13
Finland	36	30	25	11	7
Norway	48	35	40	8	13
Sweden	54	48	38	17	6

Source: Eurostat 2001, Statistics on Innovation in Europe.

The two types; product and process innovations, are often interrelated. But the data available, however, do not permit an analysis of any relation between product and process in the innovation studied. Therefore, an enterprise may have introduced a new

[92] See i.a. Hauknes 1998; Broch 1999
[93] Data are not available for the service sector. Data for Iceland is not included. See methodological comment to table 3.1 and under footnote 29.

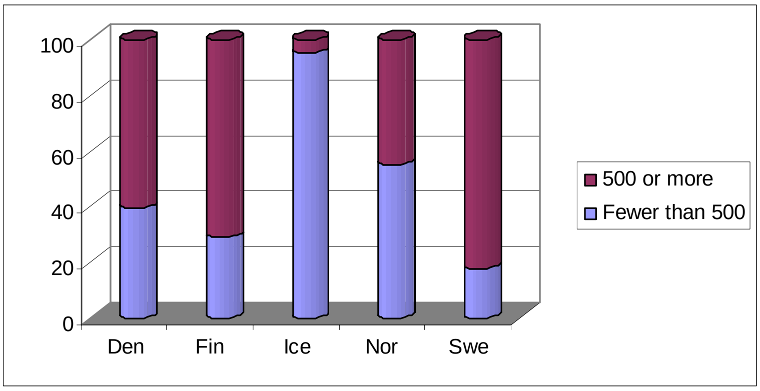
product and developed a new process without any connection to the specific product. The finding implies, however, that the majority of enterprises that innovates on products also tend to innovate on process.

The tendency is that pure product innovations outnumber pure process innovators in the Nordic countries, yet not in Norway, where there is a higher proportion on pure process innovators. This is due to the fact that Norwegian industry is dominated by companies that focus on the development of processes used by others. In Denmark the numbers are relatively high for both types, while Sweden has a quite high proportion of pure product innovations.

The industrial structure is also reflected in the size of the innovative companies. In Finland and Sweden, for example, over 70 per cent of the innovation activity is carried out in enterprises with 500 or more employees, while in Iceland only 5 per cent.

R&D and differences in industrial structure
The propensity to innovate is higher in large firms than in small firms (figure 3.4), except for Iceland where the pattern is the totally opposite. In Norway the proportion is almost 50/50, while in Sweden the proportion of large firms that reported they were innovative were almost twice as high as for small firms.

Figure 3.4: Total business R&D broken down by size classes of firms as a percentage of million PPP$, 1999[94]



Source: OECD 2001: Science, Technology and Industry Scoreboard

A comparison of the Nordic countries must take into account that the industry sectors dominating the national R&D expenditures is not the same for all countries, and that the countries industry structures differ in size (see table 1.3 employed by industry in thousands and in percentage).

Table 3.3 shows R&D intensity at industry level for each country in 1997. R&D intensity is here defined as BERD as a percentage of value added.

[94] See table 3.3. in the Statistical Annex. Data are based on a mini-questionnaire launched in 1997. The data were subsequently updated for the Meeting of the Committee for Scientific and Technological Policy (CSTP) at Ministerial level held in June 1999 and again in May 2001 for the publication *OECD Science, Technology and Industry Scoreboard 2001.* Data for Denmark is from 1998, excludes institutes and the lower cut-off point is 6 employees, data for Norway is from 1995 and excludes institutes and total manufacturing and mining only, while data for Sweden has a lower cut-off point on 50 to 99 employees.

The classification of BERD indicates that there are pronounced differences in R&D intensity, both between the Nordic countries and inward across industries.

There are however some similarities between the Nordic countries. The R&D intensity is very high in pharmaceuticals and electro equipments and relatively high for office accounting and computing machinery as well as for instruments.

The differences between R&D intensity across industries in each country can give the result that a country appear as R&D intensive, even if the intensity is limited to one or two particularly industries.

Table 3.3: R&D intensity at industry level, BERD as a percentage of value added, 1997[95]

		Denmark	Finland	Iceland	Norway	Sweden	Nordic countries
	Total industries	1,9	2,66	1,2	1,34	4,35	2,73
NACE	**Industry**						
1-5+10-14	Agriculture, hunting, forestry and mining	0,03	0,29	0,7	0,32	3,04	0,42
15-16	Food, beverages and tobacco	1,53	2,05	2,08	1,09	1,76	1,58
17-19	Textile, fur and leather	0,3	1,82	2,31	1,94	1,09	1,2
20-	Wood and cork	0,3	0,69	0	0,63	0,54	0,57
21-22	Paper, printing, publishing	0,21	1,58	0	1,09	3,08	1,89
23-24	Coke, ref. petrol and chemicals	6,01	7,15	5,69	4,98	4,27	5,48
244-	Pharmaceuticals	33,13	19,32		41,74	52,55	41,82
25-	Rubber and plastic production	2,31	6,2	2,11	3,78	4,31	4,09
26-	Non-metallic mineral products	0,76	2,18	0,92	1,78	3,08	1,89
27-	Basic metals	0,99	2,32	0,82	5,29	3,19	3,17
28-	Fabricated metals	0,41	2,69		1,11	1,78	1,56
293-	Machinery for farming and forestry	5,31	14,14	0	5,24	15,45	10,23
29-	Other machinery, nec	7,57	6,79		7,75	9,72	8,33
30-	Office, accounting and computing machinery	13,58	15,02		16,75	19,38	16,8
31-	Electrical machinery	3,2	12,78		4,99	6,48	7,2
32-	Electro equipment (radio, TV and communication	23,35	31,83		55,83	39,61	35,92
33-	Instruments	12,32	12,34	0	8,1	19,54	15,48
34-35	Ships, aerospace, other transport	1,41	5,68	1	2,78	25,71	15,95
36-37	Other manufacturing	5,29	2,52	0,72	0,47	0,94	2,79
40-41	Electricity, gas and water	0,31	1,57	0,07	0,15	0,93	0,73
45-	Construction	0,05	0,36	0,08	0,16	0,52	0,28
5,6,7,8,9	Services, other industries	1,17	0,5	1,37	0,98	0,86	0,89

Source: TemaNord 2001

Patent Data and Bibliometric Indicators

Patent data

A patent is a document determining intellectual property right relating to an invention in the technical field. This must be a novel technical invention, involving an inventive step and that is capable of industrial application.

[95] Data based on ANBERD 2000, MSTI No. 1 2000, National Account Statistics and computations made by the Danish Institute for Studies in Research and Research Policy. 1 means here that Iceland is not included because of lack of data at a sufficiently detailed level.

Patents have two fundamental functions: to publish the content of an innovation and to give the inventor the sole rights to the development and commercializing. A patent may be granted to a firm, an individual or a public body by a national patent office, and is valid for a limited period – generally 20 years.

Patent data are widely used as statistical indicators. This is caused by the close relationship between patenting and innovative output, and because patents are rich sources of information. Patent data are also readily available at marginal costs at the national and regional patent offices.

There are however certain drawbacks with the use of patent data as an indicator of innovation. Many inventions are not patented because the propensity to patent and the patent regulations differ across industries and countries. Changes in patent laws over time also make it difficult to analyse trends over time. Patents are also used to prevent competitors' access to the invention. Besides, the inventions that are patented hold no information on the differences in value-contribution to the society.

The lack of information about the heterogeneity is however a general problem with statistical data. A more distinctive problem is that there is no standard method of calculating indicators from patent data, with the result that the analytical and policy lessons that can be drawn from patent statistics diverge widely.[96]

In table 4.1 total patent applications on national territory in the Nordic countries in 1997 are presented. The figures distinguish between applications by residents of the country concerned and applications from non-residents.

Table 4.1: Patent applications, 1997

Country	National patent applications	Resident patent applications	Non-resident applications
Denmark	84335	1339	82996
Finland	83944	2390	81554
Iceland	26298	22	26276
Norway	30165	1210	28955
Sweden	88537	4192	84345

Source: OECD 2000/2: Main Science and Technology Indicators

Applications from non-residents dominate the patent applications statistic in all the Nordic countries. The majority of these are continuations of patent applications originally applied for in other countries[97].

Iceland and Norway have a relatively lower number of non-resident applications. This is partly because of a different industrial structure and market, and because of differences in patent laws. In resident patent applications it is only Sweden that shows a considerable higher number than the other countries in resident patent application.

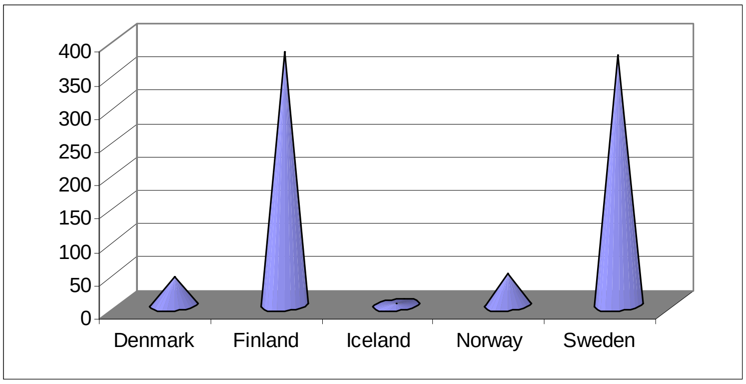
[96] Norges Forskningsråd 2001; OECD 2002: *Science Technology Industry Review No. 27.*
[97] Norges Forskningsråd 2001

The European Patent Organisation (EPO) examines patent applications for 19 European countries. When granting a patent, the rights of the inventions are protected in those European countries assigned in the application. The EPO data therefore indicates how many applicants want to protect their invention in more than one member country.

In comparing the Nordic countries it is important to be aware of that Iceland and Norway are not members of the EPO, and the numbers are not representative for the total number of patens in these two countries. Patent data from EPO are nevertheless presented here to compare the distribution in the three other countries.

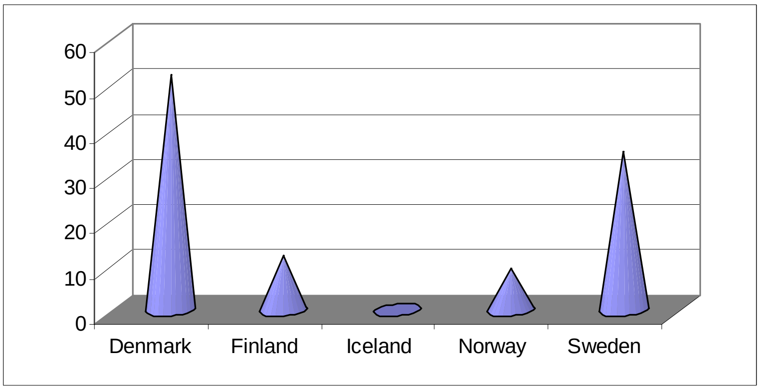
The numbers of patent applications to EPO in the information technology (ICT) sector and in the biotechnology sector are given in figure 4.1 and 4.2.[98] The propensity to patent inventions in these high-technology industries is considered more probable than in lower technology industries.

Figure 4.1: Number of patents in the ICT sector, applications to the EPO, 1997[99]



Source: OECD 2001/2: Main Science and Technology Indicators

Figure 4.2: Number of patents in the biotechnology sector, applications to the EPO, 1997[100]



Source: OECD 2001/2: Main Science and Technology Indicators

[98] reference year is year of filing
[99] See table 4.1 in the Statistical Annex.
[100] See table 4.2 in the Statistical Annex.

These figures indicate that Finland and Sweden has a much higher number of patens in the ICT sector than the other countries (which is to be expected, given the presence of Nokia and Ericsson), and that Denmark, and to a less degree Sweden, have a higher number of patents in the biotechnology sector – even though the number in total is not very high.

Using patent data as an indicator on innovation, a complete picture should be given of the patent activity classified by country of origin, industry and time. In order to illustrate this, we present patent applications in Norway according to country of origin and industry in 1993-2000.

Table 4.2: Patent applications in Norway according to country of origin and industry, 1993-2000

Country	Electrical	Instru-ments	Chemicals, Pharma-ceutics	Process industry	Mechanical industry	Consumer goods	Construction and building	Total	Total in per cent
Denmark	52	95	375	93	156	29	76	880	2
Finland	557	87	184	158	193	100	109	1393	3
France	279	325	1331	326	340	69	192	2886	6
Japan	306	108	913	116	148	28	27	1668	4
Netherlands	95	167	516	143	156	27	193	1306	3
Norway	1069	1126	794	858	3347	1097	1508	9824	21
Britain	311	264	1108	281	375	55	240	2653	6
Switzerland	117	179	861	172	401	64	85	1892	4
Sweden	735	332	530	425	517	127	257	2931	6
USA	949	1629	5791	1223	1062	251	1353	12357	26
Other countries	855	760	3881	1091	1348	334	616	8959	19
Total patent applicants	5325	5072	16284	4886	8043	2181	4656	46749	100

Source: Research Council of Norway 2001

As the table shows there are more patent applications in total numbers from USA in Norway than patents with Norwegian origin. This is because of an extremely high number of patent applications from enterprises in the chemical and pharmaceutical industry in the USA. Other unspecified countries also have a high number of applications in this industrial category. Of the patent applications with Norwegian origin most of them are in the mechanical industry. In comparing the Nordic countries, Finland and Sweden have relatively high numbers of patent applications in the electrical industry, and Denmark in chemicals and pharmaceuticals.

Except from giving a close view of the Norwegian patent data, the contribution of this table is that it illustrates that it is difficult to use patent data as an innovation indicator in comparing the Nordic countries – because of differences in industrial structure, corporate strategies, institutional practice, patent laws etc.

Bibliometric Indicators

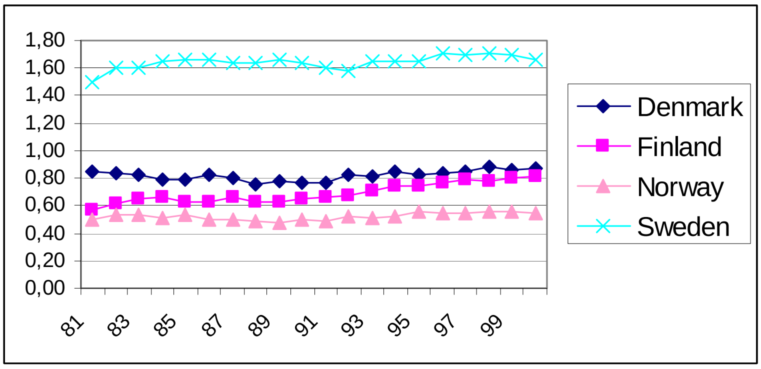
Bibliometrics is a set of analytical concepts and methods for measuring the regularities, the structure, the dynamics, the performance and the institutional setting of written knowledge production in the research system. Bibliometrics is also a tool for situating the research efforts of a country in relation to the world, the research of an institution in relation to other institutions and the research of scientific groups in relation to their own communities.[101]

The basic information unit in bibliometrics is the scientific paper. Scientific papers are registered and catalogued in international databases which can be used for bibliometric purposes.

Data presented here derives from Institute for Scientific Information (ISI). ISI holds aggregated publishing- and citation numbers classified by special fields.

There are distinctive differences in scientific production between countries. In the period from 1981 to 2000 USA had about 30 per cent of the scientific production in the world, while Britain, Germany and Japan had between 7 and 8 per cent of the production[102]. Figure 4.3 shows the development of scientific papers as a share of the scientific production in the world in four Nordic countries, counting number of scientific papers in each country according to the sum of scientific papers.

Figure 4.3 Scientific papers as a share of the scientific production in the world, 1981-2000[103]



Source: Norges Forskningsråd 2001

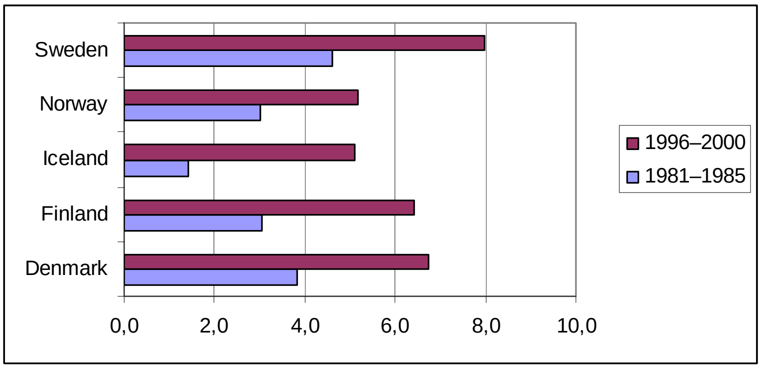
Among the Nordic countries Sweden appear as the most research-intensive one. The research intensity in Sweden, Denmark and Norway has however been quite stable during the period from 1987 to 2000. Finland shows an increase in the number of scientific papers as a share of the scientific production in the world.

Many scientific papers are written by more than one author. The consequence is therefore that the number of scientific papers becomes higher in the bibliometric data than the real number of scientific papers.

Another way to estimate the number of publications is the number of scientific papers per thousand inhabitants. Figure 4.3 shows scientific papers per thousand inhabitants in the Nordic countries in the period 1981 to 1985 and from 1996 to 2000.

[101] Okubo 1997
[102] Norges Forsningsråd 2001
[103] See table A.4.3 in the Statistical Annex

Figure 4.4 Scientific papers per thousand inhabitants, 1981-85 and 1996-2000[104]



Source: Norges Forskningsråd 2001

The scientific production in scientific papers per thousand inhabitants have increased considerable in all the Nordic countries in the period 1996 to 2000 compared to the period from 1981 to 1985. The number of periodicals included in the database is, however, extended in 1996 to 2000.

Sweden has the highest number of scientific papers per thousand inhabitants, and stands, together with Finland, for a significant increase in production of scientific papers from 1981 to 2000. Despite the fact that Iceland has the highest increase. Iceland shows however still the lowest number of scientific paper per thousand inhabitants, and is on the level with Norway.

In analysing bibliometric data it is important to be aware of that publishing pattern varies between different fields. Physics, chemistry, biology and clinical surgery have the highest publishing numbers, while social science and humanistic science have low publishing numbers. Disciplines like geology, a Norwegian favourite, are underrepresented, as are non-English publications. In comparing countries it is also important to be aware of differences in industrial structure and differences in R&D intensity, as in the use of pattern data.

A general observation can be that bibliometrics as well as patent data should be used with the outmost care when measuring the temperature of a knowledge economy. Again it is important to remember that these indicators measure *research* output, not *innovation* output in the broad sense.

Entrepreneurial activity

Another indicator measuring the innovation activity in a country is the total entrepreneurial activity (TEA). The TEA index presents the per cent of the labour force that is either actively involved in starting a new venture or is the owner or manager of a business less than 42 months old.

[104] See table A.4.4 in the Statistical Annex

***Table 5.2 Entrepreneurial Activity as a percent of the labour force, 2002*[105]**

Country	Denmark	Finland	Iceland	Norway	Sweden	GEM average
TEA Index	**6,5**	**4,6**	**11,3**	**8,7**	**4**	**8**
Percentage of national total divided on:						
Necessity based activities	**6**	**8**	**10**	**5**	**17**	**61**
Opportunity based and other reasons	**94**	**92**	**90**	**95**	**83**	**37**

Source: Global Entrepreneurship Monitor 2002, Danish National Report

Individuals participate in entrepreneurial activities for two major reasons: (a) they choose to start a business as one of several possible career options ("opportunity based") or (b) they feel compelled to start their own business because all other options for work are either absent or unsatisfactory ("necessity based").

The entrepreneurial activity in the Nordic countries is almost solely opportunity based, while the average across the nations involved in the Global Entrepreneurship Monitor 2002 indicate a much higher level of necessity-based entrepreneurial activity. To put this in perspective: In countries like Mexico or India we are more likely to find entrepreneurs starting a grocery store or a carpet shop due to lack of employment than in the Nordic countries.

The TEA index indicates some differences in the entrepreneurial activity in the Nordic countries. The percent of the labour force involved in entrepreneurial activity in Finland and Sweden is much lower than in Iceland, and these countries are also together with Denmark below the average across the nations involved in the Global Entrepreneurship Monitor 2002[106]. The TEA rate varies from 2 percent in Japan to 19 percent in Thailand.

However, the unemployment rates in the Nordic countries are relatively low, and welfare support is well developed. Few, if any, are therefore forced to establish a new enterprise out of pure need. The opportunity based index gives therefore a more relevant indicator for the entrepreneurial spirit in the Nordic countries. This indicator is also more interesting from an innovation policy point of view, as it is in this category we are more likely to find innovative companies.[107]

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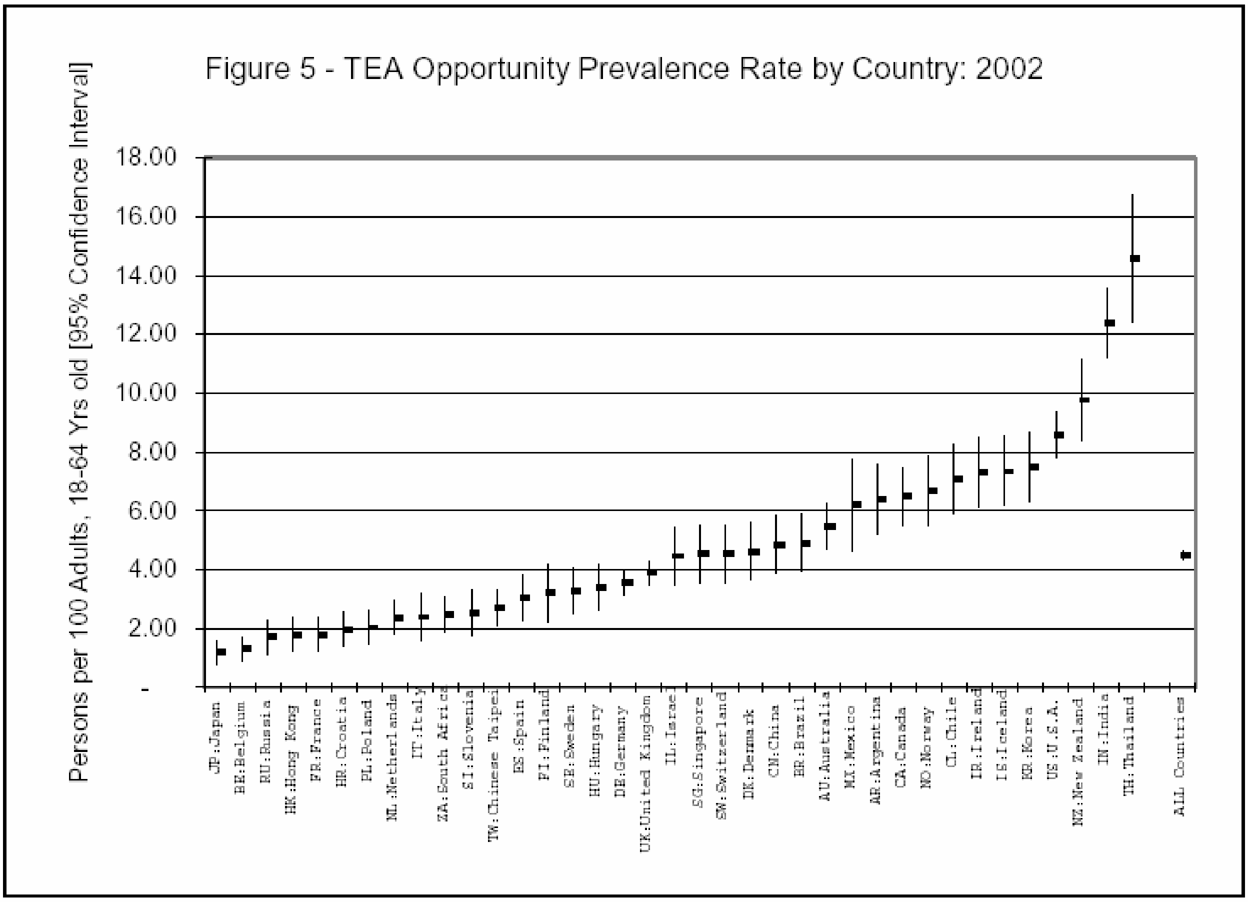
[105] TEA is based on responses of a sample of adults in the countries and from personal interviews conducted with national experts in the countries. An individual may be considered a "nascent entrepreneur" under three conditions: first, if he or she has done something – taken some action – to create a new business in the past year, second, if he or she expects to share ownership of the new firm; and third, if the firm has not yet paid salaries or wages for more than three months. In cases where the firm has paid salaries and wages for more than three months but for less than 42 months, it is classified as a "new business". Those 5 percent who qualify as both a "nascent entrepreneur" and a "new business" are counted only once. For further detail see: *Global Entrepreneurship Monitor, 2002 Executive Report.*

[106] 37 countries was involved in the Global Entrepreneurship Monitor 2002, see *Global Entrepreneurship Monitor, 2002 Executive Report* for information.

[107] One can argue that establishing a company is in itself an innovation, i.e. a change of behaviour for the ones involved. Indeed it is, and such companies may contribute a lot to the development of the business sector. However, in this connection we focus on companies that are able to contribute with new or improved products, processes or services on the market.



This figure is taken from *The Global Entrepreneurship Monitor 2002 Summary Report*, November 2002 (Paul D. Reynolds, William D. Bygrave, Erkko Autio, Michael Hay). It orders the countries according to the propensity to the establishment of new opportunity based companies. The lines delineate the limit for pure statistical noise.

According to this figure you will find Iceland and Norway among the most “entrepreneurial” countries in the world, more or less on the same level as the United States. Denmark is somewhere around the middle, while Finland and Sweden lag behind.

This is interesting, as it shows a reversal of the figures documenting R&D investments. Finland and Sweden have some of the most R&D intensive economies in the world, but these heavy R&D investments do not lead to a high level of opportunity based entrepreneurship. The GoodNIP team has not final the answer to why this is so, but we can raise some possible explanations.

The high R&D investments in Sweden and Finland are mainly caused by a few high tech companies. A high tech company is by definition a company that invest much in R&D, so this does not say much about the “knowledge intensity” of the private sector in these countries. As noted elsewhere, a company may perfectly well be knowledge intensive – in that it makes use of advanced technologies – as well as innovative and profitable, without investing money in R&D.

It could be that Finland and Sweden have invested in high tech industries (ICT) that do not easily lend themselves to widespread entrepreneurial activity. They may be too complex or too knowledge intensive. Admittedly, ICT is an important ingredient in all industries these days, but apparently it is *not* harder for Norwegian and Danish entrepreneurs to make use of this technology than for the Swedes and the Finns.

This reminds us of the figures on the number of innovators as a percentage of enterprises in the manufacturing sector above, where the numbers for the Nordic countries were 71% for Denmark, 36% for Finland, 48% percent for Norway and 54% for Sweden. (The high number for Denmark may be caused by a statistical aberration). Hence Norway, with the weakest R&D investments, can actually compete with Sweden as regards industrial innovative capabilities. Moreover, it performs better than Sweden in opportunity based entrepreneurship.

What this tells us is *not* that R&D does not matter. It does. These figures do emphasize, however, the need to develop a more nuanced view of innovation processes. R&D will help, but not if the innovation is unable to bridge the gap between research and the market in an efficient way. Moreover, there is much more to innovation than research, something the policy makers must take into consideration. Especially Sweden must look into its own innovation system and find out why the large investments in R&D are not followed by an even larger increase in entrepreneurship and innovative capabilities.

Some more figures have been included in the statistical annex on page 209.

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4. What can innovation research tell about innovation policy priorities?

By Johan Hauknes

Twenty years of innovation research has dramatically expanded our understanding of innovation as a driver for national and regional economic growth, for structural change, and welfare and social development. The expanded basis for understanding economically motivated innovative behaviour of firms and its implications at industrial and macro-economic level is closely linked to the analytical perspective of innovation as interactive – with substantial systemic elements – and that innovation, or new techno-economic behaviour by firms, finds its rationality in the market orientation and competition structure they face.

To tackle the challenge of understanding innovation as a driver for economic and social change, three inter-related insights were required,

- Firstly – and related to the market context where innovation activities enfold – there is a close integration between a price-based competition – with prices as carriers of economic information – based on firms doing 'the same things' as their competitors, and a 'technological', or non-pecuniary, competition – based on doing things differently than competitors. It is in this integrated competition, and the profit incentives and related expectations it gives rise to, that innovation has its origin and motivation. Innovation is – and must be understood in market context.

- Secondly, firms' innovation activities are shaped by their structured economic environments, and the techno-economic relations and interactions with the various parts of it. A firm's choice of innovation strategies and behaviour reflects these structures and relations with what it regards as important or relevant institutions and organisations – irrespective of the sign of this relation. The firm's options for potential new behaviour and its choices are moulded by the interaction in which it participates – a core characteristic of innovation as an economic activity is that it is interactive in a basic sense.

- Lastly, and beyond its traditional role as an information bridge or carrier between supply and demand, the market has a key role as a generator of new information, as a sorting and selection mechanism. In the dynamic interaction of the supply and demand sides some innovations – some patterns of behaviour – are selected at the expense of others. The selection criteria of this market mechanism are not given, but change dynamically as a response to the variety of behaviours of the supply side, the accommodation of these on the demand side, laying new foundations of future demand and selection criteria.

Even if this research still is in its early phases, its understanding of the relation between interactive learning of innovation capabilities and resources, variety generation and selection has had substantial impact and a wide relevance in many areas. This applies to the basic questions of requirements for a sustained welfare and economic development, to explaining important regional and sectorial differences, and so on.

Not the least, this research has contributed to renewing the basis for formulation of public innovation and regional policies – through providing a better understanding of what characterises economic growth and welfare development in advanced economies as the Nordic ones.

In this research a core challenge has been to map, describe, and theorise the real shape of innovation and innovation based competition across the regional, national and international economies. The identification of essentially micro-level drivers and major characteristics of innovation and the linking of these with meso- and macro-level structures and impacts has, as expected, proven a considerable challenge, a challenge we still are in the early stages of analysing.

Hence, this challenge still involves a wide range of unresolved questions, some of which are addressed in this programme of research.

Innovation research is a problem-oriented, multi-disciplinary research field which explores the nature, sources, creation, spread and impacts of *technological and organizational change*. Its growth dates back to the late 1970s and early 1980s, and since then researchers have explored many aspects of knowledge creation, from a wide variety of disciplinary backgrounds.

Much of this research has been empirical in character – it has consisted of quite basic research into the real characteristics of innovation, using case studies and statistical analyses. The latter have been aided, especially in the 1990s, by new data resources (especially economy-wide surveys on innovation activity and outputs), as well as enhanced R&D data, much-improved patent data, and databases on scientific publication.

The basis of the research field is the widely recognised fact that innovation and technological change are central aspects of social and economic development. Yet the driving forces of such change still remain poorly understood. Innovation studies is therefore a field which takes up the intellectual challenge of explaining the dynamics of economic, technological and organizational change.

The key insight that allows this opportunity is that innovation – and related socio-technical change – to a substantial degree is driven by economic and commercial considerations of economic agents, addressing characteristics of the market and wider economic context of these agents – innovation and technical change is an integrated part of the economic environment, and not something that is implanted into the economic system from the outside. This implies immediately that this field is part of the social sciences. This social focus of innovation studies rests on three aspects of technology and innovation:

- Firstly, innovation involves learning and the creation, development and management of productive or economic competences (see e.g. Hauknes 2000, 2003). Such learning always takes place in organizational and social contexts, and such contexts are thus an important focus of study

- Secondly, innovation involves organisation: this include the management and cooperation systems through which production takes place, but also systems of public administration and agencies which regulate economic and technological change.

- Thirdly, technology and innovation take place within broader society. On the basis of cultural and political value, society makes economic and political choices which influence the development and spread of innovations.

As a field of research it is of great importance at this time: the problems it addresses are not simply an intellectual challenge, but are of great relevance to the formation and implementation of public policy in such areas as research policy, education policy, and industrial policy. Above all, innovation studies is a field of central importance to the ability of society as a whole to shape and respond to the challenges of new technologies and to reap the potential benefits of these in a socially efficient way.

So what can this area of research and analysis provide for policy? In this note we will briefly address such issues at two different levels,

- does contemporary innovation research provide a rationale or set of rationales for industrial and innovation policies that are different from the ones that have dominated policy analysis and formulation over the last decades? To what extent have these alternative rationales been integrated into the policy framework?

- what insights and inputs does innovation research provide for formulation of innovation policy objectives, design of support schemes and instruments, their implementation and assessment of their impacts?

The interaction of research and policy – what is the task of socio-economic research?

Innovation research has provided a solid argument for the highly intertwined dynamics of innovation and technical change on the one hand, and the generation of generic technological and other functional knowledge on the other. A well acknowledged part of this is the interaction between scientific and industrial research and innovation capabilities and performance at firm level and at aggregate levels. Though often formulated in terms of the demise of a so-called 'linear model' of technological innovation, it clearly goes far beyond this.

The dynamics of the relation between socio-economic research on the one hand and the use of a research-based basis in formulation of strategies and initiatives, whether at firm or at policy level, is clearly at least as complex as that of the industrial innovation dynamics (see chapter on rationalities and policy learning below). This has similar implications for any implicit or explicit attempt to base this interaction on a model of 'linear' dynamics - of models implying a socio-economic determinacy of policy formulation.

A consequence of this is that we raise the question of how we should conceive of the role of innovation research towards innovation research. The basic tenet of this is that of the importance of the critical role, in contrast to the mandatory giving or decision making role of the researcher. At its best, the role of innovation research vis-avis innovation policy analysis and formulation is to provide the critical questions and challenges that the policy makers must relate to in his or her formulation and implementation of political objectives and initiatives –challenges that need to be addressed in the policy maker's execution of the political judgement.

This innocuous formulation has consequences beyond what we may address here, raising issues as

- the crucial role of *informed consent* between the analyst and policy maker and their relevant constituencies. This has implications in terms of formulation of syntheses and for the way uncertainty is addressed,
- openness and democratic decision making,
- the importance of interactive processed of consensus making.

This is not to deny the relevance of the researcher or analyst giving policy recommendations or prescriptions if it is required and the necessary conditions are in place. But then it becomes the policy maker's responsibility and task to relate critically to these recommendations and to the analytical and political conditions for them. Included in this is the task of critically assessing the research and political judgement that has been used in the formulation of these recommendations.

On the other hand, it is the researcher/analyst's obvious responsibility and duty to openly describe and explain the assumptions and assessment underpinning the recommendations, their importance for the formulation of these and the executed judgement. This comes on top of the duty to express and clarify the analytical and empirical basis for the recommendations and the interpretation of these.

On innovation and competition [108]

Bounded rationality, a core concept in the analysis of innovation capabilities of firms, immediately implies heterogeneity, or variety. The 'satisficing' decision making is not strong enough to ensure 'representative' decision making, let alone optimal decision making. Furthermore bounded rationality implies that outcomes of learning processes, contingent on knowledge and information processing abilities, will be far from uniform; firms will learn different things. Secondly, non-optimal behaviour of individual agents cannot ensure an aggregate optimal structure, at least without resort to a rapid selection mechanism.

Learning abilities and learning processes will show considerable variety as a consequence of bounded rationality. Generating a variety of capabilities to participate in the technological competition, this has two consequences.

First of all, it implies a variety in the technological efforts, generating a technological variety in the economic system. Secondly, it might enforce the effects of the selection mechanism, weeding out the inefficient firms more rapidly. But, as the system consists of boundedly rational actors, this again widens the scope for coexisting variety,

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[108] This and the following sections is based on Hauknes (work in progress) which will give a more thorough discussion and references to the relevant literature. For a preliminary version see Hauknes 2002.

permitting firms with different ways of behaviour to exist side by side. This has the effect of slowing down the selection mechanism, rather than speeding it up. Unless resort is made to a position of strong technological determinism, arguments of the as-if kind or representative agents, cannot have any place.

Both of the well-known analytical frameworks for analysing economic change, the neoclassical and the evolutionary and institutional economics framework (see next chapter), posit a selection mechanism with decisive effects on the outcomes of economic processes. Whereas the neoclassical framework requires a rapid selection mechanism, the assumptions of the evolutionary framework lead to a slowing down of the selection process. Combining variety generation and slowing down of the selection mechanism with the dynamic effects of a rapid technological change, evolutionary framework opens up for qualitative new dynamics in the economic system.

As the sharper neoclassical knife of selection is replaced with a blunter evolutionary selection mechanism, the firms are allowed to learn, adapt and change. In the neoclassical selection mechanism they are selected on the basis of given capabilities with little time to adapt.

The selection mechanism in an evolutionary framework must clearly based on some notion of ‘inheritance of acquired characteristics’, of learned behaviours (Nelson & Winter 1982 note, “our theory is unabashedly Lamarckian: it contemplates both the ‘inheritance’ of acquired characteristics and the timely appearance of variation under the stimulus of adversity”). An evolutionary selection mechanism is fed by preexisting variety generation, again feeding new variety.

Hence, what evolutionary approaches bring in is the potential of a boot-strapping process of economic growth – of endogenous growth. Moreover, out-of-equilibrium processes are what generate the sustained growth that enables higher levels of social benefits, albeit non-optimally distributed. Furthermore this non-optimal distribution is essential for the sustainability of the process of generating further variety; market failures are essential for creating the incentives for generating technological variety.

An important task of public policy is thus to generate a trade-off between the generation of incentive structures, non-optimal distributions and the basis for future growth on the one hand, and enforcing mechanisms that ensure reasonable social welfare distributions on the other. In general, policies intended to affect welfare distribution fall dominantly outside the scope of research policies. Put bluntly, the underlying motive of economically motivated basic research policy is to enable processes that increase overall welfare for all, through creating conditions that depend on and further develop non-optimal distributions of economic welfare.

What should the characteristics of public strategies then be? Ideally there should be a complementary relation between public and private strategies, with the complementarity being based on the difference in the objectives of the two sectors. The general approach of private actors will be to attempt to reduce technological and economic uncertainty. An essential task for public policies is on the other hand, to enhance diversity and thus increase uncertainty.

Dynamic implications of competition
As seen the evolutionary approaches to economic dynamics is based on a perception of two core inter-dependent and mutually reinforcing dimensions to competition – *viz.* a price competition of (economically) homogenous, or nearly homogenous, products and a technological competition based on the introduction of alternative economic characteristics.

Broadly we argue that market based dynamics may be seen as shaped by a neoclassical selection mechanism, with agents taking techno-economic characteristics more or less as given, and by a selection mechanism operating directly on these techno-economic characteristics of economic goods. In the traditional picture new behaviour is introduced by some entrepreneurial function or entity and diffuses throughout the market, establishing the new production regime.

In a sense, new information – and hence new expectations – is more or less automatically transformed to new behaviour. Successful behaviour is rapidly identified and diffused through the market place. With the other competition form, the selection is blunt in the sense that there is ex ante uncertainty about how the market will select new behaviour. The selection mechanism slows down, relatively speaking, as the market needs time to generate or reveal information as a basis for expectation formation.

Furthermore evolutionary arguments also should include at its core an argument that the transformation of knowledge and information about technology, whether at a generic or specific level, into behavioural characteristics is resource demanding and time consuming. This is not solely a consequence of the denial of the 'linear model' argument, but equally because the uncertainty about market selection rolls back to uncertainty about intra-firm selection or prioritisation of behaviour.

With the first dimension dominating, agents will predominantly try to imitate competitors, while if competition is characterised more strongly along the technological dimension, agents will seek variant behaviour as the main mode of market adaptation. As argued above the eventual economic dynamics and impacts of this competition is characterised by the ratio of the characteristic rates of diffusion and change in main behavioural characteristics of these forms of competition.
With this ratio we may identify three broad areas;

i) 'price related' behavioural patterns change faster than 'technologically related' patterns,

ii) 'price related' diffusion rates are of the same order as 'technologically related' diffusion rates,

iii) 'price related' behavioural change is slower than 'technologically related' diffusion.

In the table below this is depicted as a four-way table where the two diagonal cells may be seen as the same situation, situation ii) above. The table is an indicative illustration of some broad types of dynamics, and should not be taken as realistic description of capitalist dynamics. In particular the complex, fractal-like structure of technology opens up for differentiated attitudes of firms towards technology, towards standardisation and adaptation in terms of aggregate technological features and differentiation towards more disaggregated features. This clearly opens up for a much more complex landscape of market dynamics than what may be captured in this simple table.

		Technological	
		Rapid	*Slow*
Price related	*Rapid*	Highly interdependent techno-economic dynamics “Critical system”	Punctuated change “Schumpeterian gales”
	Slow	Innovation led competition with co-existing varieties “Innovation economy”	Highly interdependent dynamics “Critical system”

The welfare impact of variety
The classification suggested above is a *positive* classification, in the traditional sense of the distinction between positive and normative economics. The normative dimensions of such a classification emerge from the role variety generation and market based selection plays.

Due to the bootstrapping process that follows from endogenous technical change, the long-term social benefits in an evolutionary perspective follow from the welfare enhancements generated by the boot-strapping. In this perspective there is a trade off between the traditional regard for efficiency, or ‘optimality’, of contemporary welfare distribution and the inefficiencies that allow the bootstrapping process to work.

The major difference between neoclassical and evolutionary approaches to economic systems is related to the implications of variety on the market place. That is, of differentiated economic behaviour by economic agents. These implications have direct and different consequences for the objectives of innovation policies and for the welfare impact and goals of economic policies.

As we have seen, in both circumstances the core role of the market and the selection mechanism it embodies is to reduce variety – to select certain technological characteristics of economic behaviour at the expenditure of others. However, whereas the neoclassical market is constituted so that the selected behaviour may in principle be identified ex ante, evolutionary constituted markets do not allow for this.

In a neoclassical market system, the existence of variety is reflected in the loss of efficiency[109]. The outcome of a well-behaved competition is to restore efficiency by reducing this inefficiency. Failures in market incentives opens up for policy intervention, intervention that attempts to re-establish this variety reducing mechanism.

In an evolutionary framework the existence of variety plays a much more fundamental role. The distinguishing feature of evolutionary approaches to economic dynamics is the

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[109] Note that variety refers to variety in techno-economic characteristics. Variety that has no relevance to market incentives facing the agents is irrelevant for the economic dynamics, and is not included here.

feedback between variety generation and subsequent market selection; that the introduction of variety alters the incentive structures to firms furnished by the market environment (note that these incentives are necessarily wider than the incentive structures facing 'neoclassical' firms).

The existence of this feedback loop implies that a core part of the incentive structure facing entrepreneurial firms is that it may reward not just *reactive* responses to these incentives (achieving 'state of the art'). It generates *proactive* strategies and responses, systematic attempts by entrepreneurs to alter the market environment – to alter the incentive structures itself. Modelling of this feedback loop has been based on the replicator argument – with the use of simple replicator models. In these models the environmental selection is shaped by the overall, in some sense average, quality or 'goodness' of individual agents. Though valuable, the utility of these models are limited by the fact that

- the nature of the underlying replicators (in neo-Darwinian parlance; the '*gene'* or perhaps, as hypothesised by Dawkins for social and cultural development, the *meme*) remains unidentified,

- most of our understanding based on replicator models is based on static landscape of quality dimensions – whether one- or many-dimensional. In economic dynamics the interaction between the 'supply side' and the 'demand side' of the market is a vital part of the overall bootstrapping process – implying a continual reshaping of the selection mechanism, and hence of the topology of the selection space,

- the lack of understanding of the ontogeny/phylogeny linkage, that is between replicator and agent. In economic terms the replicator – the 'atoms' of behaviour – maybe something along the line of Nelson and Winter's routines and skills, does not map realistically onto the structure of deliberate agents – onto entrepreneuring firms.

The basic outcome of this is that in contrast to the neoclassical approach, the structure and richness of variety is related firstly to selection efficiency and then through bootstrapping to social benefits. As noted above, we can depict this as a welfare trade off between present economic welfare and benefits accrued in the future as a consequence of the bootstrapping process[110].

A core implication of this for evolutionary analysis is the well acknowledged necessity of including the shaping and structures of 'technological opportunities' into the analysis. However, I would claim more importantly, it also implies a crucial role for the 'demand side', for the formation and expression of demand of economic goods. Somewhat surprisingly, this aspect has been almost completely neglected in evolutionary analysis during the first decade of its history.

At the technology side, it should be kept in mind that what is essential is not 'objective', technological or real characteristics of economic goods. In a certain sense these

[110] As a simple metaphor to illustrate the point, we bake a smaller cake today than is actually feasible (i.e. allow inefficiencies) and accept inequities in income distribution, to be able to bake a larger cake tomorrow. In the final analysis, this of course raises the difficult question of discounting.

characteristics are irrelevant to economic dynamics. What is central are *economic* characteristics of these technological products, processes, organisations etc.

Basically, analysis of economic dynamics is concerned with economic behaviour – with what economic agents *do*. Learning, i.e. capability and skill formation and evolution, whether on a daily experiential basis, or on the basis of systematic and deliberate use of resources to acquire new capabilities, is important for economic analysis only as far as it is inter-related to behavioural characteristics. These behavioural characteristics are based on the existing expectations and perceptions of the firm or agent on the incentive structures facing the firm and the future development of these.

The capabilities, awareness etc. shaped by what we are now accustomed to call 'learning' (in a very wide sense of the word), is feeding expectation formation, shaping actions and behaviour. The information generated as a consequence of these behaviours – whether expectations are confirmed or invalidated – completes the experiential 'learning' loop. What constitutes this open loop is the perceived economic – or if you will techno-economic – characteristics of economic goods.

To illustrate: if a producer manages to convince its business environment that its good is a different specie from existing variants on the market – even though the difference may just come down to 'subjective', i.e. perceived, characteristics – it is, in the economic sense a different specie. The structures and apprehensions of the market environment are not 'objective' or technological, the structuring basis of the perceived economic 'world' is malleable.

Rationales for industrial and innovation policies

Any discussion of analytical rationales for industrial and innovation policies must start from the basis that essentially innovation policies are welfare policies, being a part of the complex of more general economic policies, with core economic welfare objectives of these policies. To make this clear; an analytical rationale for industrial innovation policies is a welfare rationale. The metaphor of cakes alluded to above illustrates some aspects of what these rationales must accommodate, but these ideas are still not developed to provide this.

A core aim of innovation research has been to 'endogenize innovation', i.e. to formulate and analyse innovation by firms as a phenomenon that is closely inter-linked with and co-determined with the business environment of the innovating firms. Attempts to establish a set of principles for understanding endogenous dynamic change in economic systems in innovation research, has now been under way for more than two decades.

Its inception and development as a research field has been strongly motivated by policy interests, maybe even to the extent of having been shaped by policy motivations and interests. Thus it is somewhat of a paradox that few attempts have been made to elicit wider welfare implications of evolutionary theorizing and the implications of this for policy challenges and implications in a systematic way.

Innovation research must stand up to this challenge. The common sense arguments often raised against welfare theory principles, based on evolutionary theorizing of innovation-led economic change, is generally based on the pervasive presence of uncertainty in economic action – and hence on formation of economic agents' expectations of future development of their business environment.

The economic future is in a sense co-created with the selection in the market on the basis of explorative introduction of behavioral variety by economic agents. First of all this implies the non-existence of an optimal schedule. It also implies inequitable distribution in the form of temporary innovation rents, ultimately destroyed by the diffusion of successful behavioural strategies.

Innovation rents are intimately linked to the growth generating process as these are essential parts of the market incentives for innovation based competition. Hence there is an implicit regard for a welfare trade off between contemporary inequities in the form of rents and increased future income levels.

Arguments like these are taken as implying the non-viability of a welfare theory based on evolutionary principles. This conclusion is un-warranted. Rather, what it implies is that an evolutionary welfare theory must be fundamentally different from the standard welfare theory. Rather, some elements of an evolutionary welfare theory have already been introduced in the literature, various welfare arguments have been made on the basis of concepts like technological lock-ins and other so-called systems failures. The concept of systems failures was introduced as a way of extending the vocabulary of standard welfare theory.

To understand more clearly what these rationales may be, it helps to discuss more in detail the rationale for innovation policies that has formed the backbone of innovation policy formulation in most of the post-war period.

The post-war economic rationale for innovation policies – the Arrow-Nelson rationale

The basic economic justification for science and technology policies in the post-war period (in addition to the fulfilment of government and public needs such as defence, health and environment) has been a market failure argument. Markets may fail to operate efficiently for a variety of reasons including externalities, asymmetric information, economies of scale and scope, indivisibilities, barriers to entry etc.

As such it comes out as a direct consequence of the standard and well corroborated economic welfare theory and the related theory of social choice that was developed during the 1950s. Due to the economic characteristics of 'technological knowledge' there are associated failures in the construction and functioning of markets providing these economic goods. This implies that market based provision of such knowledge will not attain a socially efficient level – there is a positive or negative gap between social and private profits in the production of technological knowledge.

This is the essential basis of the so-called Arrow-Nelson rationale for innovation policies. Innovation - the attainment of a competitive advantage over competitors - is basically about generating and using knowledge of what to produce and how to produce it. The question is then: Are there sufficiently efficient markets for such technical knowledge?

Arrow (1962), see also Nelson (1959), gave the answer to this question: no, there are not such markets! Generation of such knowledge (the prime model being through R&D) by the market system is insufficient to achieve optimality. There are three basic factors that limit the attainment of a social optimum through private profit optimisation:

- Outcomes of knowledge generating processes are *uncertain*.
- Knowledge is a (quasi-) *public good*, implying inappropriability.
- There are substantial *indivisibilities* in knowledge generation.

The Arrow-Nelson argument, which grew out of US policy debate in the 1950s on the role of federal S&T policies, has been widely used and further corroborated in the international S&T policy debate since then. The argument grew out of a debate that primarily questioned the role of the federal basic science enterprise (see Nelson (1959)), and was particularly attuned to strengthen the basis for an idea of a 'social contract' that arose in the aftermath of the Vannevar Bush report.

A requisite for the argument for public intervention to hold, is an acceptance of science-based knowledge as being more or less directly productive, requiring not more than routinised transformation/interpretation from its generic, usually codified forms to the specific, mostly tacit, forms that are directly 'applicable' in productive activities. As a consequence there is no need for distinguishing between a science infrastructure, i.e. a science-based knowledge stock, and a stock of productive intangible assets comprising the industrial technology/competence/knowledge base.

Underlying this interpretation is the microeconomic theory of the firm. This theory implies a particular interpretation of technical information and knowledge: such knowledge is *generic*, *codified*, *immediately accessible* and *directly productive*. Hence there is no difference between capabilities, knowledge and information. Technological knowledge and technological competences are in essence just the possesion of technical information. These properties are necessary conditions to attain optimality – allowing rational optimising behaviour by firms – and for a very simple reason. Any restrictions of these would violate the conditions for competitive behaviour.

Here lies the first limitation of the rationale. By equating productive capabilities and information its foundation is at most limited to 'technological clubs', and then to applied rather than basic research - whereas the latter is what the rationale originally was developed for. For a discussion of this see Hauknes 1998b.

The market failure rationale is in principle a strong rationale. It provides:

- A general rationale (optimisation of social benefits);
- A guide to policy action (a framework for assessing links between benefits and policy inputs including funding); and
- A guide for determining optimal use of government expenditure (where; how much).

This is a strong and important rationale. The policy recommendation that follows from the Arrow-Nelson rationale implies that such socially beneficial knowledge generation (read R&D) should be publicly provided or subsidised. The implications of this classical market-failure rationale can best be summarised as follows.

Create favourable *framework conditions* to facilitate the smooth and dynamic functioning of markets, e.g. through vigorous competition policy, smooth macroeconomic policy or regulatory reform and through enabling new markets for S&T products (as through patent regulation. Then correct essential market failures by public provision or subsidising private production of the S&T products. This proved a strong argument for public R&D policies from the late 1950s onwards. Its strength was achieved not the least as it complemented three trends and views in this period:

- A 'production line' interpretation of R&D and innovation - the so-called *linear model*;
- Economic growth and technical change were regarded as dominantly *capital embodied* - sophisticated capital equipment codifying productive knowledge; and
- Advanced manufacturing and new industrial (techno-)structures were vanguard sectors - *'technology push'*.

Systemic innovation – a basis for innovation policy rationales

Why is the Arrow-Nelson rational not viable? The simple answer is that it is misrepresents the basic characteristics and determinants underlying economic dynamics, and the process of innovation of firms. What is often termed a resource based, evolutionary theory of the firm – or a theory of the innovating firm – must include

- non-price, or 'technological' competition and its integration with price competition,
- the development and mobilisation of productive, or techno-economic, capabilities in the firm, and the complex interactions of this sticky and localised capability base with external repositories of knowledge and information,
- the boundedness of capabilities and rationalities in the firm, and understanding innovation primarily as a business activity,
- as a consequence firms show what is non-optimising (satisficing) behaviour,
- with associated innovation regimes and trajectories.
- Adapting to and attempting to alter markets' selection dynamics and criteria is a main part of the evaluation process inside the firms.

The role and importance of variety generation, selection on the market and adaptation is a key driver of economic change – a core element of the dynamics in capitalist systems. In a sense the process is driven by market failure, with incessant change being the essential feature of capitalism.

The need for new rationales

The strength of the neoclassical market-failure argument is its clarity. It suggests a simple criterion for judging when government intervention is appropriate. However it has limitations in capturing the key elements of technological progress and thus has limits as a rationale and guide for technology policy making (OECD, 1998). Limitations of market failure analysis in regard to technological progress and innovation have been analysed in the 80s and 90s. The complexity of the process makes it difficult to identify and even to define market failure. Firstly it ignores the broader institutional framework that defines how markets work. Secondly it implicitly assumes that the market mechanisms have a competitive advantage over other mechanisms in all industrial technological and interface activities relevant for policy purposes. Lastly it may fail in providing direction and focus to policies when externalities are pervasive (Teubal, 1998). Absence of markets may rather be a strong signal that other coordinating mechanisms are more effective in terms of resource allocation, viz. networks, associations, communities a.o. (Nelson, 1987).

Neoclassic economic analysis has not ignored the subject of technology. Rather an explicit examination of technology and of knowledge about technology has simply been suppressed by introducing certain assumptions into the theory of the firm. Central have been the assumptions of a given set of tastes and some given stock of technological knowledge. Given this knowledge of tastes and technology the firm determines its optimal behaviour including the choice of technique through the explicit consideration of factor prices (Rosenberg, 1994).

Is the Arrow-Nelson or market failure rationale sufficient as a basis for innovation policies? It is not. It involves a misrepresentation of what underlies the dynamics of advanced economies. Learning is active, interactive, collaborative and ongoing. Innovation is multi-organisational, multi-functional and systemic. These insights lead to the need of rethinking the basic arguments for the use of innovation policies and their objectives.

Though still rudimentary, the understanding of systemic innovation has emphasised the importance of a resource based, evolutionary theory of the firm. Such models of the firm have as main aspects the role of non-price competition on markets, that firms rely in their activities on a wide range of techno-economic capabilities that must be essentially learned, the boundedness of the capabilities and rationalities that shape firm behaviour, leading to satisficing behaviour, a non-optimising form of behaviour. Such arguments lead on to the role of evolution and selection in shaping economic change, and to structures innovation patterns, to innovation regimes and trajectories.

With this approach to economic change, capitalist systems are economic systems where variety generation and adaptation are basic ingredients, and where innovation on the one hand and diffusion on the other – are complementary processes. The diffusion process is in itself a process of continual adoption, adaptation and reorientation by firms, of innovation; innovation and diffusion turns a Janus face towards us.

The processes of change in economic systems are processes that are crucially linked to heterogeneity, to 'bootstrapping' of economic growth and to structural change. In contrast to the market failure framework that allows use of the welfare theorems, the inefficiency related to knowledge generation is not limited to separated markets, it is a feature affecting all markets. In a sense the situation may be characterised by saying that all is market failure.

That relations between actors and hence co-ordination of production activities in any economic system involve two dual and concomitant processes, flows of economic resources in transaction and production processes and transformation and transmittal of information that shape co-ordination and behaviour, is an integral part of our understanding of economic systems.

The last decades have shown increased attention to the complexity and important role of the latter process in shaping economic development. Though our understanding of the why's and how's of these processes and their relations are still lacking, our understanding of them is substantially improved. The notion of information as public good has increasingly been turned around by the realisation that the functionalities of bridging between the two, which necessarily involves interpretation of externally acquired information, indeed gives information properties of (at least partial) excludability and rivalry.

In evolutionary economic theories technology change and innovation is the most important factor behind economic evolution. The study of how technology advances and its driving forces and consequences is at the centre of evolutionary analysis. Technological change is presented as a two-stage process: one stage for generating variety in technology (innovations) and one stage for selecting across that variety to produce patterns of change (diffusion of innovations). There is also a third stage, namely feedback from the selection process to the development of further variation.

If an evolutionary perspective is applied to the traditional sources of market failure, the analysis changes in subtle but important ways. Far from constituting failures, asymmetric information is essential if the competitive process is to work in an evolutionary fashion. Without asymmetry there can be neither novelty nor variety. Spillovers only make sense in a world where firms are fundamentally differentiated with respect to what they know (Metcalfe and Georghiou, 1998).
Technological advance and innovation is characterised by constant interplay and mutual learning between different types of knowledge and actors. Technological change can be seen as a learning process, which is gradual and cumulative in character and leads to a relatively ordered pattern of innovations (technology trajectories). Firms build upon their existing knowledge base when they search for new innovation opportunities, but they also use external sources of knowledge in this search (Metcalfe 1997, Metcalfe and Georghiou, 1998, Carlsson and Jacobsson, 1997).

Overall performance is thus not only dependent on how specific actors perform but also on how they interact with each other as elements of an innovation system. This division of labour in the generation of innovations means that no firm can be self-sufficient in regard to knowledge and thus gains from linkages with other knowledge generating organisations. Through their innovative activities firms establish relations with other organisations such as other firms, universities and R&D-institutes. If these market and non-market organisations interact poorly, technology change may be slowed.

Mismatches between elements in an innovation system are by OECD defined as systemic failures. If systemic failure exists then there is a rationale for policy intervention aiming at accelerating the rate of technological advance and innovation (OECD, 1998).

It is however right to say that the improvement in understanding of innovation in market systems has not been paralleled by development of the basic rationales of policy formulation and intervention. There have, however, over the last years been some attempts to raise issues and formulate some of the questions involved.

The aim of what follows is not to give a review of these developments but to raise some aspects that are shared by these and conclusions as to the policy making process. The prime shared aspect of these approaches, that is in fact shared by all known approaches to innovation analysis, is the acceptance of the significance of beneficial externalities of technical knowledge, and the importance of innovation as a determinant of economic growth and welfare development. As phrased by Bengt-Åke Lundvall recently, "Innovation is at the core of the competitiveness of firms, regions and nations" (Lundvall 1998).

The recognition of innovation as a process involving many actors and taking place in a complex institutional system is the basis of system failure rationales for policy; a policy that focuses on promoting the generation of innovations. The innovation processes are influenced not only by market forces but also by the character of the entire innovation system. Thus system rationales give justification for going beyond remedying market failures (Carlsson and Jacobsson, 1997). According to these rationales policies should try to alter the structural conditions under which technology advance and innovations occurs rather than just as in the market failure rationale altering the cost and pay off associated with R&D.

System-based welfare arguments for innovation policy

So where does this leave us? A long range of system perspectives and arguments have been used in analysing economic change. In fact it may be claimed that system arguments have always been at the core of the explanations of economic evolution and change – with roots back to the 18th century French physiocrats understanding of the economic system. Similarly Adam Smith's analytical distinction between productive and unproductive labour was a reflection of a system view on analysing economic phenomena. Though clearly system-based, these and other similar approaches were not using the system perspective tp provide a dynamic understanding of economic evolution. More recently, system arguments have proliferated and with stronger dynamic perspectives, such as

- the theory of industrial districts developed first by Alfred Marshall,
- with links to localisation and other agglomeration theories and analysis of production systems, esp in the field of economic geography,
- Bain's now somewhat outdated Structure, Conduct, Performance paradigm on industrial development,
- the analysis of historicity in technology systems by Thomas Hughes,
- the outline of *filières* and their structures by Francois Perroux,
- various industrial cluster approaches, as Erik Dahmen's development blocks, Michael Porter's clusters, etc.,
- the French *Règulation* school, with Richard Boyer and others,
- actor-network theories and the concept of techno-economic network, from Michel Callon, Bruno Latour, and others
- analysis of technological systems by Bo Carlsson, primarily in the context of the swedish STS-programme,
- the concept of sectoral systems, originating with Franco Malerba,

- a long range of ideas and concepts related to Nelson and Winter's 1977 ideas of structures of technological development, as technological paradigms (Giovanni Dosi), guideposts, landscapes or regimes (Sahal), etc.
- institutional and neocorporatist approaches to economic development has a long history starting with Torstein Veblen,
- networks and social embeddedness (Jan Johanson, Richard Smelzer).

Broadly, we may distinguish system arguments concerning four arenas of economic dynamics, from where they have their focus,

♦ the development and deployment of technical knowledge, i.e. primarily based on systematic dependencies in technology inputs and resources,

♦ systematic interactions and dependencies in the provision and utilisation of economic resources, as factor inputs, other inputs and so on. Here the concern is basically at the operations of the economic production system,

♦ market interactions and relations. Here a core concern would be the primary interaction of variety generation and selection at the market place, with the interlinkage of suppply and demand factors,

♦ lastly, several approaches have their main focus at the core institutional set-up of the economic or wider socio-economic system. This is where the market is constituted through regulation of f.i. private property, and where the institutional arrangement for financial provision and distribution is formed.

It is readily seen that all these are relevant and important, and that the long range of system approaches provide valuable insights.

As is emphasised throughout this note, we do not yet have a welfare oriented and system based rationale for industrial and wider economic policies – with the immediate difficulties it implies to present discussions of e.g. competition policies as to the operationalisation of the concept of 'dynamic efficiency' criteria. Similarly the formulation of overall objectives and priorities for innovation policies are complicated.

What the literature suggests is that the welfare and dynamic efficiency improvements are related to the structure of the competition along both of the noted axes, and that market based and co-determined economic viability has a relation to economic welfare. This implies that in some sense economic viability relates to the concept of system 'fitness' in evolutionary theories.

With robustness of selected varieties towards changes in the economic environment being a probable vital element of this welfare concept, this immediately suggests that one core aim of innovation policies is to intensify the technologically oriented innovation competition. So as with traditional arguments pertaining to the price competition and the attainment of 'static efficiency', there is a core message concerning the structure of the competition.

However – and this is another point of divergence – the integrated 'techno-pecuniary' competition is based on an interplay of variety generation and intra-variety competition. The consequence of this is that the integration of market, economic and technological system characteristics. Along the technological dimension, there is clearly a task for public policies to assure efficient production of technology and the capabilities to

transform this into productive competences at the firm level. In the case of sub-efficient levels of competition on the market, it may be a task for public policy to ensure additional actors become technologically able to participate in the competition. Along the economic dimension structural inadequacies may for similar reasons provide a rationale for the support of specific groups of firms, f.i. SMEs or firms localised in specific areas.
What we are seeing here is essentially innovation policies seen as a combination of initiatives towards

- the efficiency of capability and competence development,
- the efficiency of economic production and production systems,
- the structure and characteristics of competition.

The overall rationale must address each of this in part and in integration[111]. Whatever such a welfare based rationale for industrial and innovation policies may look like in the end, its development should be a core concern in the future, for innovation research as well as for the innovation policy system.

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[111] One important lesson may be immediately drawn from this. The success of innovation policies in terms of its welfare rationale is in terms of innovations – i.e. behavioural changes of firms – overall, and not in terms of (commercially) successful innovations; and hence not of ‘picking the right solution’ or ‘the winner’. Innovation policy should basically be neutral to what innovation is selected in the market place – the concern of these policies is the structure of competition.

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Appendix: Innovation Policy Trends in the Nordic Countries, historical reviews

In this appendix we survey historical trends in innovation policies in the respective Nordic countries, with emphasis on the last two decades. Both breaks and continuities in the formulation and implementation of policies of importance to innovation – including science and technology policies, educational policies, etc. – are identified, and discussed in a broader economic and political context.

The survey is not an attempt to make rigid periodizations of innovation policies in the Nordic countries, but rather to improve our understanding of this policy area by outlining and comparing central developments over time.

Denmark

By Jørgen Lindgaard Pedersen, Søren Jensen and Kasper Edwards

In this paper there will be given an overview of Danish technology policy after the Second World War with emphasis on continuity and breaks. The main problem is not to list up all events and initiatives. The challenge is to draw lines and identify patterns. In these years we can find lots of interest in technology policy in Denmark from politicians, Government, administration, business and universities. To understand the present debate and politics it can be useful to take a look at the longer historical lines and the more comprehensive connections.

A problem is that there is very little scientific work to draw on. One of the most worked through publications is Peter Munk Christiansen's "Teknologi mellem stat og marked. Dansk teknologipolitik 1970 – 1987."[112] In this work, which is based on the author's Ph.D. thesis we are given 361 pages historical and analytical description and analysis. The landscape is seen from a political science perspective which means that an initiative will be mentioned and discussed if it is initiated by the political system with the intention to influence technology. Niels Christian Sidenius has worked with more or less the same topics, but has used the term 'industrial policy.'[113] Finally, we can find some relevant information inside the black box called 'research policy'.

Even though there is very little work done which covers the whole field of technology policy we can find more literature about policies with the intention to influence specific technologies. Historically important technology specific policies have been made in respect to construction technology, energy technology, information technology, biotechnology, material technology, food technology and some other technologies. In several of these cases there have been made scientific analyses and assessments. But it shall be mentioned that a good part of these initiatives have not been called technology policy but rather housing policy, energy policy, etc.

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[112] Munk Christiansen, Peter, *Teknologi mellem stat og marked. Dansk teknologipolitik 1970 – 1987*, Århus: Forlaget Politica, 1988

[113] Niels Chr. Sidenius in different publications mentioned in Peter Munk Christiansen op. cit. pp. 350-351.

Important sources for further work to understand technology policy are materials from relevant ministries, research councils and committees.

Technology policy as one dimension of the general policy – from Marshall Help to oil crisis in the 1970s

The most productive way to describe technology policy and its development will be to conceptualize it as one dimension of the general policy. Even if engineering, industrial and bureaucratic pressure groups always work for political decisions including public funds for technological development, there shall be specific and strong arguments for political initiatives in these fields. There are so many competing interests in society and some of them are of much more direct importance for politicians, e.g. because they represent voters which can change their vote in the next parliamentary election.

After the end of the Second World War in 1945 and the beginning of the Cold War from 1946 the U.S. policy vis-à-vis Western Europe was characterized by a welfare dimension to keep people's minds from communist sympathies, as well as a warfare dimension to protect capitalism or the market economic system in this part of the world.

The welfare dimension was sought achieved by a combination of a massive transfer of resources from the U.S., especially productive resources, and a gradual opening up of the economies for movements of goods and capital. The Marshall Help was the organizational form during the period 1948-1952 for this transfer of resources from U.S. to Western Europe. The military dimension was NATO, which was founded in 1949 with the receivers of Marshall Help and some other countries as members.

In post war Denmark it was clear for most politicians and experts in universities and administration that agriculture could not continue to be the dominant balance of payment trade as it had been from the last decades of the 19th century. In a small and very open economy like the Danish the necessary transformation could only take place if other balance of payment trades could be expanded in the course of a relatively short period of time. It was assessed that industry was the sector with sufficiently volume, with minor supplements from shipping and international trade.

The transformation presupposed the direction of investments and transfer of labor into industry. However, resources locked up in agriculture could not immediately be used in industry. Other competencies were needed in industry than those present in agriculture. Also, housing had to be concentrated closer to workplaces. In order to recruit female labor into industry, child care and other types of welfare work would have to be rationalized. And finally, transport infrastructure had to be adjusted to the changed demand for transport services.

If we begin with the extraordinary initiatives introduced, we can make the following list:

- The Marshall Help, which was not in itself a support measure for research and development in new technology but grants and loans to Western European governments including the Danish, gave 13 billions USD (88 billions 1997-USD) to these governments. Denmark got 273 million DKK[114]. The funds were used for import of oil, vehicles, tractors and agricultural machinery, as well as machinery for industry. In Denmark the Ministry of Commerce, which had the responsibility for industry, established a so-called Committee of Productivity. The Committee worked actively for the transfer of knowledge of modern (read: American) technology in industry and agriculture. These activities were also supported by consultancies which helped to diffuse new technology including new organizational forms and incentives.

- One especially important activity, which was more or less contemporary with the Marshall Help, was the modernization of construction technology and buildings (especially dwellings) in Denmark. This modernization consisted first of all in a standardization of all dimensions of components with the decimeter as standard unit. Secondly, there was a demand that the use of direct labor in construction work should be less than 85 % of the use in traditional construction. This demand should be fulfilled as a precondition for getting state loans with a favorable rate of interest. In 1947, *Institut for Byggeforskning* (Institute for Construction Research) was established. The institute was later renamed *Statens Byggeforskningsinstitut*, and again *Bo og Byg Statens Byggeforskningsinstitut*.
- In the 1950ies *Forsøgsanlæg Risø* was founded. Its main purpose was to conduct research and development in the field of non-military applications of nuclear power. During the first 10-15 years, this objective was in focus. When nuclear power became excluded as an energy source in Denmark during the 1960ies however, other fields of research were introduced. Breeding of agricultural plants, alternative energy sources and new materials are only a few examples. When the industry for the production of windmills for electricity production experienced a take-off from the end of 1970ies, Risø became host of *Prøvestationen for Vindmøller* (Test station for windmills).
- The so-called *Godkendte Teknologiske Serviceinstitutter, GTS* - which are private consultant firms approved by the relevant ministry – had been founded in 1937. In the immediate post war period, the GTS institutes received a reasonable part of public money for private technology development.
- The first oil crisis in 1973-74 hit the public and politicians in Denmark very hard, primarily because the country at that time did not have oil and natural gas of any magnitude compared with the Danish need for energy. Nuclear power was no alternative, first of all because it was politically impossible, and secondly, because it would take about ten years to construct a nuclear power plant before any electricity would be ready for use in society. Thus, it was technologically, economically and politically an urgent need to find other solutions. Programs for the development of alternative energy were established, especially in wind energy. Also programs for energy saving, e.g. insulation, improvements of windows and support for energy saving in industrial production processes, were introduced. These initiatives were combined with duties on energy consumption.

[114] *Agro-Nyt*, Vol 9, No 6, June 1997, pp. 1-2

High technology policies

In 1982 Denmark changed government from a Social Democratic to a Conservative - Liberal. Because the former Social Democratic Government in fact had squeezed the traditional instruments in the fiscal, monetary and income policies to the maximum of their efficiency, the new Government assessed that new instruments were needed. The giving up of the price-wage indexation just after the new Government had taken seat, marked the end of the traditional political instruments. In this situation, the vision of massive resources to high tech development came as sent from heaven. It was not an original governmental initiative but a diffused idea from the international scene in the OECD and the EU.

Thus, Denmark entered a phase with high tech programs. The next then years were dominated by such programs, in the field of IT, biotechnology, materials and food technology. The most interesting feature of these programs was the relatively large amounts of money they received every year in time spans of 6-10 years, even if the programs formally had a duration of 3-4 years.

Two interesting observations can be made on the economic development during the 1980ies. First, it is interesting to see that during the mid-eighties (1984-1987, both years included) Danish industry showed negative rates of growth in labor productivity, in average 2 % per year. [115] Secondly, the wages as percentage of national income, corrected for changes in trade structure, grew during the same period - from 65, 2 to 66, 7.[116] A reasonable interpretation of these two tendencies is that the labor force was not qualified to handle all the new technology, especially not IT. Subsequently the wage quote rose, partly because of the up-come of bottlenecks in more specialized labor markets, and partly because the general level of unemployment fell from 10, 9 to 7, 9 during the period.[117]

After these dramatic first years of the High Tech Program Period, different government initiatives were taken. The IT -Program was not prolonged with a program number two, and in fact not all money in the program was given to applications. Also, the programs in biotechnology and new materials, and some not so high tech oriented programs e.g. in food industry, were spread over a longer period than the case was in the IT-Program.

The normal period between Marshall Help and high tech programs

If we shall get an impression of what happened in Danish technology policy during the second half of the 20th century, we cannot be content with only discussing the dramatic initiatives representing breaks with the development trends. These trends are characterized by stable rates of growth in funds allocated to different technologies for their inventive and innovative development and diffusion. During most of the period we have only small changes in the internal distribution of governmental resources between different technologies. Furthermore, we have a more or less constant organizational structure for handling allocation of resources.

[115] 'Statistisk Tiårsoversigt 1994', *Danmarks Statistik*, København, 1994, p. 106
[116] Op cit p. 49.
[117] Op cit p. 49.

One out of several possible explanations for this phenomenon can be found in the fact that most of the public resources dedicated to day-to-day activities in technological development are distributed by committees that are dominated by persons from institutions which are potential applicants of these funds. In such a system we can argue that the relative distribution of funds will be more or less stable. The distribution of applications will be stable in the short run because the number of persons working with different technologies can be expected to be more or less stable. And it is not politically correct from Ministers or Ministries to appoint people as a hidden way of changing the allocation of funds in a radical way.

Trend shifts in public resources allocated to technological purposes can be explained by changes in relative distribution between public and private funds, or by growth in total resources to technological purposes with a constant distribution between public and private sources. A further dimension is of course the fact that the number of Danish researchers will influence the size of funds. On the other hand, the same number will also affect the amount of funds applied for.

Seen from the perspective of organizational and political decision making processes, however, we can say that under certain circumstances coalitions of strong actors in business, trade unions, administration and political life are formed which are able to push through decisions for extra money for wanted purposes. The first example of this in the post war period can be identified around the time of the Marshall Help from the end of 1940ies. The second example can be found during the ten-year period following 1983.

Institutions and structure

From our perspective, there are three types of institutions that have a more permanent existence:

1. Universities
2. Sector research institutions
3. GTS-institutes

In the transformation periods we can find ad hoc organizations such as:

1. Program committees
2. Centers with a semi-permanent existence

1. Universities

Until 1928 Denmark had only one university, the University of Copenhagen which was established in 1479. In 1928 the University of Århus was founded as a full university. In 1965, 1971 and 1973 respectively, another three new universities were established - in Odense, Roskilde and Aalborg.

It should be noticed, however, that business schools and institutions for academic technical research and teaching were not called universities until the middle of 1990ies, even if they during the whole post war period in fact were universities – if not full universities in the sense that they covered all scientific subjects. The forerunner of what today is called the Technical University of Denmark was in fact established in 1829, and in 1851 the Royal Veterinary and Agricultural University was founded. The latter is the only agricultural university in Denmark.

2. Sector research institutions

Sector research institutions were founded as institutions which were to serve Ministries in specific subjects where research was a prerequisite for qualified advices and/or production.

3. GTS-institutes

A third important pillar in the Danish technology policy system is the so called Advanced Technology Group - in Danish *Godkendt Teknologisk Service system*, *GTS* - which consists of ten institutes. The institutes are private institutions but they are subsidized from public funds with basic resources. Today the public funds represent 11 % of turnover.

4. Program committees

In the different ad hoc programs - such as the Marshall Help in the 1950ies, the IT-program in the 1980ies, the Biotechnology programs from the beginning of the 1980ies, and the later programs on food technology and material technology - relatively large resources were allocated during short periods, typically five to ten years.

5. Centers with a semi-permanent existence

One way to manage funds connected to large programs has been to create centers which traditionally have been coalitions between different smaller units and designed for a time span longer than a project period but shorter than a permanent institute.

Ideologies in technology policy

In principle we cannot find one single clear formulation of Danish technology policy: The aims, the instruments or the optimal sums of funds. There are of course some general formulations for universities and other institutions and programs saying something about the importance of transforming new results from natural sciences into technology of utility in Danish companies. But it seems that in general the basic idea is that in normal times Government and Parliament will not decide which specific technologies shall be preferred. These decisions are delegated to committees with representatives from business, science and Ministries. But when technology policies are becoming hot political issues, Government and Parliament are directly involved in decisions about technology. Maybe the politicians are reluctant to take part in decisions on concrete applications, but not on types of wanted projects.

One important trend which can be identified from the period, and especially from the 1990ies, is the more and more explicitly articulated claim for the utility of science to business. Naturally everybody wants society, including business, to make use of results from science. However, the issue is more complex. From the first European universities were founded in Late Middle Ages they had to fight for their independence from Church and/or King. Today they have to fight for independence from Business. In practice the most serious problem is perhaps not Business, but politicians thinking they can help Business by giving their representatives power in governing universities and research institutions.

New government – new organization, new priorities and no more resources

In November 2001 Denmark got a new right wing Government with its parliamentary majority based on the Danish People's Party. What generally has happened of relevance for innovation and technology policy is first of all increased focus on the importance of knowledge and new technology. More importantly, perhaps, is the introduction of new institutions, e.g. a new Ministry of Science, Technology and Innovation which has been proclaimed as an instrument to make universities more business friendly and to promote activities with the intention of making it more interesting for universities to take part in transforming research into commercial activities. One important thing in this connection is a proposed change in the act governing universities, implying that a board appointed from the Ministry with a majority of representatives from private business will select Principals. Institutional innovations have also been made in the regional support system.

What will happen in the long run remains to be seen – we can observe different trends in different countries, including the Nordic countries. One expected development is that universities will become more elitist. Also, research institutes as centres of basic research and the existing universities will probably become institutions for the production of candidates without research based teaching.

Finland

By Juha Oksanen

During the last years the development of national technology policies in Finland has been dealt with in several research papers and publications. The official expression of and explanation for Finnish science and technology policy has been announced by the Science and Technology Policy Council of Finland, which every third year publishes a review summarising main trends and presenting targets for future developments.

Also, Finnish researchers have found the development and theoretical underpinnings of the national technology policy an interesting research theme. Tarmo Lemola has studied 'the long wave' of Finnish technology policy in several articles and reports (e.g. 2001a, 2001b, 2001c). Mikko Rask (2001) has analysed values underlying technology policy from a conceptual and systemic point of view. Riikka Eela's study (2001) focuses on the ideas that have shaped science and technology policy in Finland. She bases her analysis on the reviews published by the Science and Technology Policy Council between 1973 and 2000.

Key concepts of Finnish science and technology policy in the 1990s – national innovation systems and clusters - and their use in policy-making have been analysed thoroughly recently. In his dissertation, Jääskeläinen (2001) studied the import of diamond and cluster models into Finland, the dissemination of these models and the reasons for their widespread acceptance. Miettinen (2002) has analysed in depth the development of the concept of national innovation system and its rhetorical use in technology policy-making in Finland.

This overview of trends in Finnish innovation policies proceeds chronologically from the past to the present. The focus is on the development of Finnish technology policy from the 1970s onwards. However, the post-war period preceding 1970 is also covered to some extent in order to set more recent development into a wider historical perspective.

From World War II to the 1970s - groundwork for national technology policy

The history of Finnish science and technology policy can be divided into three main lines, which have been developing parallel to each other. First, there is scientific research and its development; secondly, the development of university education and its administration; and thirdly, the connection between industry and the previously mentioned factors. (Lönnqvist & Nykänen, 1999, 4)

The scientific and political systems approached each other gradually in the 1930s and 1940s. Debate on the development of university and technical education increased in Finland in the 1940s. At the same time more attention was paid to the significance of research work in certain industrial field. The debate became more focused after the establishment of the Technical Research Centre of Finland (later known also as VTT) in 1942. The public debate was however still sporadic and rested mainly on opinions of individual researchers or persons with technical background. (Lönnqvist & Nykänen, 1999, 7)

The State started to develop scientific-technical research more intentionally from the 1940s and the 1950s. An important signpost in the development of science and research policy was the establishment of the Academy of Finland at the turn of the 1950s. Before the 1960s Finland had no industrial policy in its modern sense, as Jääskeläinen (2001, 16-19) notes. Public industrial policy support for firms was minor at best. For example, between World War I and II the Government did not give any direct support for industry but focused its efforts on the development of an operational environment for industry. The policy of that time was in line with negative stances among Finnish trade and industry circles towards public intervention in business life. Even the term 'industrial policy' was not used. At that time government policy concerning operational preconditions for industry focused on the creation of basic structures of science, education and technology. Also, the creation of state-owned companies demanded the Government's attention.

The Ministry of Trade and Industry's role in industrial policy-making became more explicit only in the latter part of the 1950s. The history of industrial policy is however longer if we understand it as public activity which has economic, scientific and educational aspects. In the beginning of the 1950s a political discussion had started about the geographical concentration of industry and the problems the weaker regions were facing because of this development. The Ministry of Trade and Industry presented its first financing instruments for industrial policy needs in 1956 in forms of two loan schemes: pienteollisuuslaina ('loan for small enterprises') and vientimaksulaina ('loan for export fee). (Jääskeläinen, 2001, 17-18)

In the 1950s the foreign trade was opened up step by step, something which gradually caused new competitive challenges for Finnish industry. More intense international trade relations also gave impetus for new needs concerning competencies and technologies. Still, industry regarded with a certain suspicion the idea that industrial policy issues would be dealt by a strong public body. Therefore the matters linked to industrial policy were taken care of by the Ministry of Finance and the commercial policy department of the Foreign Ministry. The Ministry of Trade and Industry's role was not strengthened until the end of the 1950s. (Jääskeläinen, 2001, 17)

Birth of science and technology policy

Lönnqvist and Nykänen have identified the birth of Finnish technology policy in the period from 1956 to 1968. During that period views about the economic importance of natural and technical sciences became more clarified. After the mid-1950s, a wider debate on the development of research work and technical education took place. Themes which raised attention were linking considerations and the needs of industry and production for a reform of science, research and university policy. Especially commentators from the University of Technology and the National Technical Research Centre, VTT voiced these issues in the public debate.

Lemola dates the institutionalisation of science and technology policy to the early 1960s. At that time a number of changes took place that were favourable for the formation of the new policy area. These factors included positive economic development and changes in political power structures. Generally, the 1960s opened up a lot of opportunities for collective and private initiatives, and created new procedures for cooperation and competition. According to Lemola, actors and interest groups concerned with science and technology were particularly well prepared to make use of these new opportunities. Thus, in a short period science and technology policy became a significant and widely accepted part of the Finnish ‘modernisation project’. (Lemola, 2001b)

The report of the Industry Advisory Board in 1959 defined public policy’s role in a way that has strong resemblance with ideas pronounced 40 years later. The advisory board viewed with certain reservation the Government’s possibilities to intervene in industry development by means of a coherent industrial policy. The advisory board saw it advisable that the Government would focus its attention on the creation of general preconditions for industrialisation so that this activity could take place in the most profitable way possible, also with respect to the total benefit for the national economy. According to the report, the creation of these preconditions depended decisively on state finances. Education, public procurement, activities of state-owned firms, export guarantees and loans, as well as the strengthening of firm’s financing and other non-public financing were defined as the most important means of industrial policy. (Jääskeläinen, 2001, 18-19)

During the 1960s higher education and science policy were coupled closer with industrial and regional policies - e.g. science policy was strengthened by the establishment of new universities in different regions of the country. Industrial policy as a term became established in the late 1960s and it was also accepted more widely by various stakeholders. (Jääskeläinen, 2002, 59)

The Ministry of Trade and Industry launched a new instrument for the funding of research and development in 1966. At the same time the right to deduct research expenditures from taxation was strengthened. Later, the introduction of these new instruments supporting firms’ R&D activities has been interpreted as one of the first signs of an emerging technology policy. Sitra, the Finnish National Fund for Research and Development was founded in 1967. The new organisation’s tasks consisted in accelerating the country’s economic growth, optimising the location of industry, and increasing the efficiency of public investments. In the 1970s the application of new technologies and supporting innovation was emphasised as parts of Sitra’s tasks. (Michelsen, 1993)

The development and geographical decentralisation of higher education played a significant role in the development of Finnish science and technology policy during the 1950s and the 1960s. Decentralisation of higher education outside of the capital area was an issue already in the early 1950s, when a committee was appointed to consider development of higher education. The issue was brought up again at the turn of the 1960s by President Kekkonen, who demanded a planned science policy and an extension of university sector. The demands, preparation and legislative work resulted in the founding of new higher educational institutions around the country and the growth of research and education in natural sciences, technical sciences and social sciences. (Jääskeläinen, 2001, 20)

At the end of the 1960s, the government appointed KTM-68 committee reformed and strengthened industrial policy substantially. The committee established the term industrial policy in the discussion: The committee called for a systematic industrial policy and the establishment of necessary planning apparatus. The committee also recommended that industrial policy and technology policy should be disentangled from each other, that a policy promoting industrial R&D should be created and that funding for goal oriented research should be increased. In the committee's opinion active industrial policy belonged to the tasks of the Ministry of Trade and Industry, contrary to the earlier view that 'Government's appropriate role is to be a night-watch'. The broad definition of industrial policy was seen to include different policy sectors from financing, research and development, and still further, education and energy policies. All these policy areas should be moulded into a solid and even industrial policy.

The KTM-68 committee proposed that the administration dealing with industrial matters should create a development policy for industrial R&D, which would focus on development of new and modified products and production processes. It was recommended that project based, goal oriented research funding should be increased in order to ensure economic growth. The committee also recommended reforming the organisation of the Ministry of Trade and Industry, so that a separate industrial policy line and a technology office were established within the Ministry. (Jääskeläinen, 2001, 21)

Role of international good practices

In views of some experts, the decisions concerning development of science and technology policy in Finland have not been particularly unique in an international perspective. For example, Lemola (2001, 31) reminds us that organisational solutions and policy instruments have been copied in many instances from more advanced countries of the time. In first decades after World War II the Swedish example had an especially strong influence on Finnish decisions on the organisation of science and technology policy. From the mid-1960s onwards OECD also became an important and highly valued 'trend-setter' for Finnish decision-makers. Still today OECD is one of the international actors whose opinions are listened carefully to by science and technology policy-makers in Finland.

In the 1940s and 1950s international examples of the development of technical-scientific activity were sought from Scandinavia, Central-Europe and Anglo-Saxon countries. The OECD countries were an especially important source for statistical reviews of technical research. At the end of the 1950s the newly created assignments of technical attachés in Finnish embassies constituted a channel for information about development abroad. The technical attachés were reporting about technical development and research in their host countries. The role of the technical attachés was in focus in the beginning of the 1960s. Especially Sweden served as an example when the development of the tasks of the attachés was considered. (Lönnqvist & Nykänen, 1999, 25)

International examples also played an important role when the Science Council of Finland was founded in 1963. The administrative and scientific model for the Council was found in Sweden, where a body called *Forskningsberedningen* was carrying out similar tasks. The establishment of a similar kinds of science councils and committees for the co-ordination of plans concerning science and higher educational policies was an European wide phenomenon. (Lönnqvist & Nykänen, 1999, 26)

The tasks of the Science Council included general coordination of the plans and actions concerning the promotion of research. The Council should also control important research related plans and appropriation proposals and make statements to the Government when needed. In addition, the Council's assignment encompassed a number of other issues: Participation in international research co-operation, allocation of research resources between ministries, legislation concerning research and development work, as well as the establishment and reform of research institutes. Administratively the Science Council was subordinate to the Ministry of Education.

1968-1975 - realisation of earlier policy decisions

In the 1960s the development of science and technology policy was characterized by continuation: Principles and questions brought forth in the previous decade were now matters of administration and concrete decision-making. This development resulted in the institutionalisation of science and technology policy by the end of the 1960s. As a result, definitions of policy were ready made when the new decade, the 1970s, started.

Significant institutional reforms within the public sector were carried out during the last years of the 1960s. Sitra, the Finnish National Fund for Research and Development was founded 1967 and a reform of the Academy of Finland was implemented couple of years later, in 1969. An administratively important step was taken in the beginning of the 1970s, when industrial policy and technology policy were institutionally and administratively separated from each other. The industry department of the Ministry of Trade and Industry was divided into separate lines for industrial policy, technology policy and energy policy, and the staff of the industrial department was increased. (e.g. Lönnqvist & Nykänen, 1999, 32)

The development of science and technology policy was not centrally co-ordinated at that time: Different stakeholders and actors in the research system were involved in the process which led to the birth of a new policy area. The impacts of the decisions were however long lasting. For example, the separation of science and technology administration in the end of the 1960s has left its mark on later developments. The responsibility for the administration of science and technology policy was divided between the Ministry of Education and the Ministry of Trade and Industry. The former was responsible for science and institutions directly related to basic research and its promotion (the Academy of Finland and universities), whereas technology policy belonged to the Ministry of Trade and Industry's line of duty. Increase of resources for research and development work became a focus area in the Ministry of Trade and Industry. Additional resources were to be targeted to technical research institutes (VTT), technical universities and companies' R&D work in the form of loans and non-repayable support. (Lemola, 2001a, 33)

The Science Council, a government advisory body, was one of the actors participating in defining of national science and technology policy. The council did not restrict itself only to matters of science and research. Also aspects of technology policy found their way to the reviews of the Science Council, even though the issues of technology policy did not directly belong to the council's sphere of authority. Questions of technology policy have been touched upon in the reviews from the first review in 1973 and onwards. The handling of issues related to technology policy was motivated by the importance of scientific-technical research for economic growth, among other reasons. (Eela, 2001, 17)

The emphasis in the arguments used for legitimizing the Government's intervention in the development of science and technology has changed over the time. In the first review of the Science Council, in 1973, the Government is presented as a competent actor setting national goals for science and research policy: The Government has to intervene, because the scientific research is increasingly affecting society. It is Government's role to ensure that the direction science moves in is in compliance with the broader societal goals. The State is also presented as an international benefactor: The solution of global problems requires that research activities are increased also in Finland. The third line of justification used at that time underlined the State's task to promote the adaptation of society to general international developments and to technical developments in particular. (Eela, 2001, 20)

According to Michelsen (1993, 262-263), the technology policy of the 1970s focused mainly on the quantitative growth of the research system. This policy line supported the adaptation of industry to changes in markets. Policies aiming to increase the competitiveness of industry through qualitative actions were implemented to a lesser extent.

Different kinds of thoughts were also presented in the policy discussion of the 1970s. The industry department of the Ministry of Trade and Industry published a review in 1972 which dealt with development traits of industry during the decade. In the review the primary tasks of economic and industrial policies was defined to be acceleration of structural change in industry, improvement of operating preconditions of industry and supporting growth of industrial output. Expansion of production should be directed to competitive sectors and areas with growth potential.

A watershed in the development of Finnish technology policy was the year 1979, when the Government appointed a broadly based Technology Committee to assess technical development and its impacts and to propose actions by which beneficial effects could be increased, harmful could be reduced and technical know-how strengthened.

The Technology Committee highlighted in its report the role of automation and micro-electronics, which according to the committee would radically change the industrial structure of industrialised countries in the course of 1980s. In the committee's opinion the development of automation would decrease and change the demand for workers, accelerate manufacturing processes and intensify competition. The committee concluded that forceful technology policy actions would be required in order to keep the impacts of automation under control. Therefore, the committee urged the Government to make initiatives, which would secure the competitiveness of Finland's industry and service sectors. In addition, the committee noted that industry must prepare itself to take advantage of the expansion of micro-electronics, to develop telecommunication and data-processing, to create automatic production control systems and to familiarize itself with the newest knowledge of bio- and material technology. (Michelsen, 1993, 263)

Lemola remarks (2001b, 21), that the Technology Committee's principal recommendations included the strengthening of science and technology policy both quantitatively (increased resources) and qualitatively (allocation of resources to the fields of high technology). The committee recommended that financing of research and development work should be increased immediately to a level equivalent of 2 percent of GDP. At the same it was seen necessary to create a system through which it could be possible to develop enterprises' operational preconditions as well as their responsiveness to innovation. The committee also recommended that the basics of information technology and technology in general should be included into the curricula. (Michelsen, 1993, 264)

The Technology Committee's work also laid the basis for the creation of the national technology agency, Tekes, a couple of years later. The committee urged a reform of the organisation of the Ministry of Trade and Industry. This recommendation led the Government to appoint the KTM-81 Committee to untangle reform requirements both within the Ministry and its administrative field. The KTM-81 Committee recommended that technology policy planning and steering in Finland should be subsumed within an administrative body, which would be subordinate to the Ministry of Trade and industry but not although belonging to the Ministry's organisation.

The 1980s - big programmes and new institutions

In the 1980s technology policy became more interventionist in Finland. Another visible phenomenon in the 1980s was the strengthening of technology policy. Part of that change was the restructuring of the institutional landscape of the policy area. At the same time the development of a broad based industrial policy was emphasized, which was reflected by the gradual convergence of science and technology policies. (cf. Jääskeläinen, 2002, 60)

Active exploitation of the opportunities opened up by new technologies for the benefit of economic growth and employment became the guideline for the Finnish science and technology policy in the 1980s. If the earlier phase of science and technology policy had been characterized by the construction and renewal of the institutions and organisations of the R&D system, a distinctive feature of the new policy was increasing government involvement in the promotion of industrial innovation. A belief in rational policymaking came back, but science with social objectives was replaced by technology and competitiveness of industry as the main guideline. (Lemola, 2001b, 21)

A new organisation, Tekes, the National Technology Agency was established in 1983 as the key planner and executor of the new technology oriented policy. Tekes was designed after the model of the Swedish Board for Technical Development (*Styrelsen för teknisk utveckling*). Later, the founding of Tekes has been identified to be an important turning point in public R&D funding in Finland. The new organisation grew rapidly into the role of the most important R&D funding body of the country. Promising international examples from Japan and Sweden encouraged Finnish technology policy makers to include national technology programmes into Tekes' service and instrument portfolio. The new instrument was not only developed to channel public funding but also to draw together and strengthen co-operation between universities, government research institutes and companies.

In the 1980s, information technologies were the focus area of Tekes' activities - in line with the recommendations of the Technology Committee some years earlier. Technology programmes relating to information technologies were launched already in the end of the 1970s, prior to the establishment of Tekes. One dealt with solid state technology and another with information technology. In the latter part of the decade Tekes was criticized for having been too much oriented towards information technologies at the cost of basic industry. According to Lemola this criticism was not wholly justified, because the share of information technology in Tekes' funding had been decreasing during the last part of the 1980s. (Lemola, 2001a, 40)

The establishment of the Science and Technology Policy Council in 1987 was another significant institutional reform in the 1980s. The transformation the Science Policy Council underwent in order to become reborn as the Science and Technology Policy Council manifests the technology orientation of the decade. (Lemola, 2001b, 23)

In its first review in 1987 the new-born Science and Technology Policy Council lists the creation of Tekes as the most important development in technology policy during the decade. The review further states that technology policy has been established as one of the focus areas in the national policy sphere in the 1980s. Eela (2001, 17), who has studied the reviews of Science and Technology Policy Council thoroughly, maintains that in the review in 1987 technology policy is understood to be a kind of lobbying in relation to other policy sectors: The creation of favourable conditions and environment for innovation demands influence on financial and educational policies, among other things. To put it more neutrally, this stance represents the idea of co-ordinating public policies and actions in order to increase chances to achieve the goals deemed to be desirable.

Besides institutional reforms of the science and technology policy field, the internationalisation of R&D activities was taking big leaps forward in the 1980s. Efforts were made to increase and develop international research interaction especially with Western-European organisations. Until then, Finland had avoided to bind itself too closely to research activities which had connections to the European Commission (ESF, CERN, ESA). Previously, official research collaboration was mostly geared towards Nordic co-operation and bilateral co-operation with socialist countries. At individual researcher level close ties and co-operation took place with researchers from Western Europe and the USA. For example, the exchange programmes had offered for talented Finnish researchers an opportunity to study in the USA already from the 1950s-1960s. (Lemola, 2001a, 40)

The first official step towards closer official relations with Western-European R&D partners was taken in 1985, when Finland joined Eureka. Tekes played an important role in that case. Tekes was also a prominent actor when Finland started to prepare for participation in the framework programmes of the EU, which were opened to Finland in 1987. Participation in the EU research programmes became a substantial part of Finnish science and technology policy at the end of the 1980s.

Lemola (2001a) assesses that technology transfer and commercialisation was a third visible trend in the Finnish science and technology policy of the 1980s. Utilization of results of R&D activities was under discussion already in the 1970s but with somewhat different emphasis: At that time utilization of research results was referring mainly to needs to improve library and information services, develop ways to inform decision-makers and the public about science, and tighten links between researchers and users of research results. A new phase began in the middle of the 1980s when first technology centres (or 'villages' as they were known at that time) and technology transfer companies were founded. The first technology centre of Finland was founded in Oulu in 1982.

Technology transfer and commercialization of research results were gradually getting more attention also in Tekes' technology programmes. The basis for technology transfer and utilization of research results was laid in the 1980s and the founding of technology centres had an especially strong regional and political support. The technology centres were understood to support regional political aims to promote even development between regions. The centres were even seen to offer an opportunity to promote the kind of public services that stimulate the development and introduction of new technologies in SMEs.

The 1990s - consolidation of systemic policy-making

When reviewing Finland's recent history the economic depression in the beginning of the 1990's cannot be left unmentioned. In the beginning of the decade the Finnish national economy entered a very severe crisis. Between 1990-1993 gross national product (GDP) figures dropped 13 percent, the national currency - markka - devalued almost 40 percent and unemployment peaked close to 20 percent. Also the bank system was in serious crisis which eventually led to a new alignment of the whole banking business in Finland. The negative economic spiral had deteriorating effects on the state finances: At the same time as tax incomes dropped, the need for public expenditure rose. This, in turn, caused both a deficit in the state budget and external debt. (e.g. Lemola, 2001a, 44)

What caused the economic crisis of the early 1990s? There were both internal and external reasons for the crisis, as many researchers have pointed out. External causes which are often referred to are the sharp rises in European interest rates and the collapse of Soviet Union, which was an important trading partner for Finland. Some researchers, though, maintain that the role of external factors has been emphasized too much in the discussion about the economic crisis (cf. Honkapohja & Koskela, 1999 and Kiander, 2001). According to them, the key reasons for the crisis were internal, e.g. the poorly designed deregulation of financial markets in the 1980s and the crumbling of the overheated 'casino economy' of the late 1980s. However, the relative contribution of external and internal factors to the economic crisis remains an open and politically sensitive issue.

In the middle of economic crisis the Government launched a preparation for a new national industrial strategy. According to Jääskeläinen (2002, 61), the reasons for launching this strategy work were several: The rapidly weakening situation of the national economy and state finances, the need for structural reform of the Finnish economy, the deterioration of Finland's international competitiveness, the upsurge of unemployment and the impacts of the European integration process on the general framework of economic policy-making. In the face of mounting challenges, demands for national strategies targeting problem areas emerged. The Government responded quickly to these demands by commissioning several crisis analyses and programmes on in 1992.

The creation of the new industrial policy strategy was carried out in small working groups, the core of which consisted in two officials of the Ministry of Trade and Industry and a senior researcher of ETLA, the Research Institute of the Finnish Economy. This was a new approach. Previously, a committee presenting a wide selection of interested parties and stakeholders would have been nominated to draft a policy strategy. Now, however, the small working groups were chosen to prepare a strategy in order to accomplish work quickly and produce guidelines for reform of industrial policy. The decision to assign the preparation to the small expert groups was also a way to avoid conflict of interests. The strategy aimed among other things at adopting modern industrial policy thinking, sketching solutions which could target Finland's problems in the 1990s and strengthening the position of the Ministry of Trade and Industry in industrial policy-making. (Jääskeläinen, 2002, 61)

The new industrial strategy was prepared within short time span from autumn 1992 to spring 1993. Preparation of the industrial strategy gained a lot from an on-going project of ETLA. So called cluster research project analysed Finnish industry and competitiveness. Theoretically the project applied Porter's diamond and cluster models in Finnish context and the ideas and results of the project were used in the redefinition of Finnish industrial policy. This theoretical underpinnings were also clearly stated in the strategy rapport (1993, 42), according to which "Porter's competitiveness model offers a natural framework for contemplation of a new industrial policy". (See also Miettinen, 2002, 135).

The redefined strategy made clear distinction between the old and new industrial policies. The old industrial policy was described to consist of direct subsidies for firms as well as regional and sectoral subventions. Also public planning trying to direct structural development and the production decisions of companies was seen as an important element in the old approach. The new sketched industrial strategy meant 'the end of having a dispersed system of supports and financial aid', as it was put in the report (1993, 43).

Juxtaposition of the old and the new way of thinking can be seen even at the level of policy goals: 'the goal is not the reallocation of current resources but rather the influencing of quantity and quality of resources to be born in the future'. The new guidelines for industrial policy promoted structural changes indirectly by targeting the areas where markets are working insufficiently (cf. the market failure argument), by utilizing external effects of investments in R&D, by developing production factors (mainly know-how and research) and by advancing the working of markets. (Jääskeläinen, 2002, 61-62)

The redefined national industrial strategy was welcomed by various stakeholders. It gave impetus for discussion in different policy areas and its lifecycle has been unusually long. Jääskeläinen (2002, 62) sees a number of reasons for the popularity of the new industrial strategy. As a policy guideline the strategy was based on an exceptionally thorough analysis of business life, economic development, policy environment and pressures for a change of policy tools. Arguments for industrial policy were based on concepts from topical research, which gave more credibility for the strategy also among those who were not directly involved with industrial policy-making.

The framework adopted in the industrial strategy coupled together different stakeholders, the language was largely understood and things could be said in fresh and clear ways in order to induce action. In addition, Porter's diamond model was used to explain and illustrate why a wide approach of industrial policy-making was a necessity. The cluster model did not itself provide content or direction for the new policy, as such. Instead, it served as a instrument the various stakeholders could use to speak about the new policy. (Jääskeläinen, 2001, 128 and Miettinen, 2002, 136)

The basic idea behind the approach was presented already in 1981 by the KTM-81 committee which made a proposition for an extensive industrial policy. The committee had proposed that the goals of industrial policy should be followed up in all relevant policy areas. This wide definition of industrial policy was again presented in the national industrial strategy of 1993 and the policy spheres included were defined more carefully than earlier.

A consequence of this wide definition was that industrial policy did not stay as a sectoral policy per se. Instead it was transformed into a policy which touched upon the goals and activities of society as a whole – the perspective of industrial policy broadened from industrial sector policy to national social policy. In this way the diamond model presented in the industrial strategy in 1993 translated into a political programme, which defined key areas of national competitiveness, policy arenas and the role of Government. (Jääskeläinen 2001 and 2002)

Later on, the cluster approach was applied more widely in the context of an additional appropriation for research programme, which Government approved in 1996. The additional funding programme worth FIM 1,5 billion (€ 252 million) was implemented in the years 1997-1999 and part of the increased funding was channelled through eight cluster programmes, which were formed under five sectoral ministries. The international expert group, which performed an overall evaluation of the additional appropriation programme, concluded that the idea of a cluster programme was one of the main new elements in the additional funding of research from 1997. (Prihti et al, 2000, 34 and 51)

Jääskeläinen (2002, 67) crystallizes the role of the cluster concept in the Finnish policy-making of the 1990s in the following way: 'the concept has served as a framework for research and method, as a description of economy, as a means of policy-making, as a means of strengthening the role and influence of an organisation (MTI) and as an expression of modernist attitude'.

Technology policy and recovery from the economic crisis

The impact of the economic crisis on R&D expenditure was surprisingly short-lived. In the midst of the crisis (1989-1993) the average real annual growth in R&D expenditure dropped to around one percent, whereas in preceding years (1983-1987) it had been about 10 percent. The average annual growth of the R&D expenditure of firms in the years 1989-1993 was about 0.3 percent, whereas the corresponding figure over the same period was 1 percent for the universities. The growth rate of R&D expenditure towards the end of the 1990s climbed back to over 10 percent. (Lemola, 2001c, 11)

The deep economic crisis did however cause a commonly felt 'sense of urgency' to redirect economic development. This sense of urgency also paved the way for a re-allocation of massive amounts of government budgets in the favour of science and technology policy in the 1990s. A reflection of this is the government decision to increase public investments in R&D through the additional appropriation for research programme (1997-1999).

Official guidelines for science and technology policy were changing at the turn of the 1990s. Two concepts, 'a national innovation system' and 'knowledge and know-how', were building blocks of the new science and technology policy paradigm. It was the

Science and Technology Policy Council that in its Review in 1990 introduced both concepts in the official Finnish technology policy discussion. (Lemola 2001a. Also Eela 2001)

With the emergence of the concept of national innovation system the role of the State in technology policy was redefined. In the earlier reviews the State was seen to be the principal goal-setter of the technology policy. In the new policy framework the role of the State is to be an providing actor, which supports other actors in the innovation system to achieve the targets they have set for themselves. The other principal actors were in this discourse understood to be mainly enterprises. (Eela, 2001, 23)

The Review of 1990 defines the national innovation system as follows: NIS is a whole, which includes all factors affecting to development and utilization of new knowledge and know-how. Eela maintains that the factors are not referring to actors, but somewhat ambiguously to 'features' of the national innovation system. Representatives of research, education, business and administrative circles are understood to be actors in the innovation system. The national research system (including universities, research institutes and company R&D), education, the general social atmosphere, interaction and co-operation between actors, internationalisation and factors having an impact on innovation creation and diffusion are listed in the review among the features of the innovation system. (Eela, 2001, 24)

The breakthrough of cluster thinking in the policy discourse took place concurrently with the breakthrough of the concept of the national innovation system. As mentioned above, Porter's idea of clusters was welcomed by Finnish policy-makers and researchers both in the field of technology policy and industrial policy. The titles of publications from the mid-nineties tell something about the interest cluster thinking evoked in Finland. Ylä-Anttila's paper *Industrial Clusters - A Key to New Industrialisation?* came out in 1994. Two years later, in 1996 Ylä-Anttila published with Vartia a paper called *Technology Policy and Industrial Clusters in a Small Open Economy - The Case of Finland.*

In the wake of the breakthrough of innovation system and cluster thinking, the justification for policy-making shifted somewhat. The use of innovation systems as a framework for policy-making set additional demands on education and research. The Science and Technology Policy Council's review in 1996 notes that education and research are considered more and more from utilitarian viewpoint – among other things, the funding decisions and allocation of public resources for R&D testified for that. This shift was welcomed in the review and potential dangers, such as directing education too short-sightedly, were to be avoided through regular evaluations. (Eela, 2001, 22)

In general, evaluation was increasingly understood in the 1990s as an instrument suitable for controlling and monitoring the functioning of various facets of the national innovation system. The Finnish science and technology policy field had seen the emergence of evaluation efforts already in the early 1980s. The first efforts inspired by international examples and internal considerations were carried out at the Academy of Finland and the Technical Research Centre of Finland, VTT in 1983. The Academy of Finland was primarily interested in carrying out evaluations in scientific fields, whereas the evaluations at the VTT focused on the institute's research programmes. Some years later, Tekes adopted the evaluation model in its technology programme procedures. It was however in the next decade, the 1990s, that evaluation really anchored in the Finnish research and development system. (Oksanen, 2000, 16)

The Science and Technology Policy Council played an important role in the nurturing of evaluation practices on the Finnish R&D scene. The Council actively promoted the diffusion of evaluation activities into different areas of the country's public R&D system. For example, as a part of the development of sectoral research, the Council recommended in 1995 that all sectoral research institutes should be evaluated by the end of the decade. This was included in the official action programme for the development of sectoral research, which was approved by the Council in 1996. Around the same time, a recommendation to evaluate all Finnish universities before the turn of the century was also made. These two proposals have had an important role in diffusing and establishing the institutional evaluation practice in Finland. (Oksanen, 2000, 17)

All in all, the diffusion of the evaluation activities has been profound: Between the beginning of the 1980s and 2000 over 170 evaluations connected to R&D were carried out. The focus of the evaluations has evolved as the evaluation practise has been diffused to new areas and as changes have occurred in societal interests. In the 1980s and in the early 90s evaluations focused more on the quality of Finnish research, on the positions of basic research, and on the conditions of research. Since then, more attention has been paid to the relevance and impact of public R&D activities, and to the efficiency of organizational operation and strategic questions. (Oksanen, 2000, 17-20)

The emerging role of regions

The strengthening of regional innovation policy is according to Lemola (2001, 46-49) one of the reforms of the Finnish science and technology policy which took place in the 1990s. The establishment of the regional centres of expertise programme is a clear expression of the development. The first programme period was launched in 1994, a year before Finland's accession to the EU. The second programme period started in 2000 and runs to 2006. The new instrument did not in itself increase funding for R&D significantly - rather the centres of expertise programme is an umbrella-like instrument assisting regions in targeting resources in areas which are defined as strategic. The regional centres of expertise programme also constitute a national instrument of channelling the EU funding that is meant for regional development. (cf. also Miettinen, 2002, 81-82)

The first years of the new century - a quest for new landmarks of national technology policy

In the Science and Technology Policy Council's review in 2000 the adaptation of society to a changing environment is defined as one of the tasks of policy-making. According to the text we are currently living in the midst of epochal break, which is assumed to last for a long time. Working co-operation between private and public sectors within the framework of the national innovation system and continuous development of the system are among of the requirements which are needed when times are changing. (Eela, 2001, 22)

The idea of the role of State in the Science and Technology Policy Council's review in 2000 differs markedly from the earlier reviews. The public sector is now understood to be first of all a facilitator and promoter, which opens the way for new success stories of individuals and companies. A control function is no longer part of the Government's role. Instead focus is on co-operation and securing good starting points for other actors. (Eela, 2001, 25)

Lately, new challenges have emerged for national technology policy. Various signs hint that the resource and input oriented technology policy paradigm is at a crossroads. After years of substantial increases in R&D financing Finland has reached the international top league as to the share of R&D expenditures of GDP. The private sector stands for the major part of the increase in R&D expenditures but public funding also rose substantially during the second part of the 1990s. Additional government input to R&D was channelled through the additional appropriation for research programme, which was implemented between 1996 and 1999. Resources for the programme were generated by privatizing government owned businesses. At the moment there are no equivalent additional sources of finance at hand.

There is no longer common consensus among policy-makers that more public resources should be put into R&D and technology policy. Major national technology policy organisations, such as the Ministry of Trade and Industry, Tekes and VTT, alongside the national federation of employers have pronounced repeatedly concerns because the government funding of R&D has not increased at the same pace as in the end of the 1990s. According to these arguments government funding of R&D has stayed more or less on the same level for the last three years (2000-2002). This turn in policy is maintained to threaten the competitiveness of Finnish companies and Finland in the long run.

During the 1990s large public investments in R&D were made in order to support a restructuring process of the Finnish industry and economy. Recently this strategy is being cautiously questioned especially by policy-makers responsible for state finances. Even if the strategy was fruitful in the past it may no longer be an adequate basis for future science and technology policy. Some commentators have also remarked that the growth of government spending on R&D has not stopped but increased more modestly for the last 3 years compared to the prior years of the additional appropriation programme.

An intriguing detail related to the debate on public support is brought up by a fresh study concerning government funding for small and medium sized enterprises in Finland. One of the findings of the study was that the total amount of government funding awarded to SMEs has over the past four years grown quite rapidly and simultaneously with increases in the availability of external finance on the marketplace. This finding raises questions about the additionality of public support - is it supplementing financial gaps found in markets or even in some instances substituting private finance? (Hyytinen & Väänänen, 2002)

European and global megatrends are also casting some doubts as to the possibilities of national technology policy-making. So far, Finnish technology policy has been a national project in essence, and its justification has rested on alleged positive impacts on welfare and development of society at large. In line with that, technology policy has been geared towards the needs of Finnish companies, whose success especially on the international market has contributed to - if not wholly determined - national welfare. In times when companies are becoming more globally minded in their strategies, this causal link is not that self-evident any more. At the same time the role of the state is curbed by the emergence of the European Union and the regions in technology policy-making. ‘New public participants necessitate an alternative view of public intervention in research and innovation’ (Mustar & Laredo, 2002, 67). It seems that technology policy-making is not any longer the monopoly of the national states.

The Ministry of Trade and Industry’s new technology policy guidelines for the years 2003-2006 include some, even though cautious, references to challenges. The guidelines emphasize the need to be capable of identifying changes and new phenomena as well as new possibilities and chances created by changes. It is seen necessary that the innovation environment is developed more dynamically in order for it to be able to respond proactively to the needs of tomorrow’s operational environment - and not just react to the requirements of changing environment. Dynamism and flexibility of actors involved in innovation activities and technology policy is defined to be decisive for the efficiency of the innovation environment as well. The adjusted definition of technology policy points out that efficient national innovation environment ensures Finland’s international competitiveness also in future. The growing importance of international and European-wide arrangements in technology policy-making is covered directly in the guidelines, according to which utilization of European research and technology co-operation and other international co-operation related to business and technology policy is an important part of the national innovation environment.

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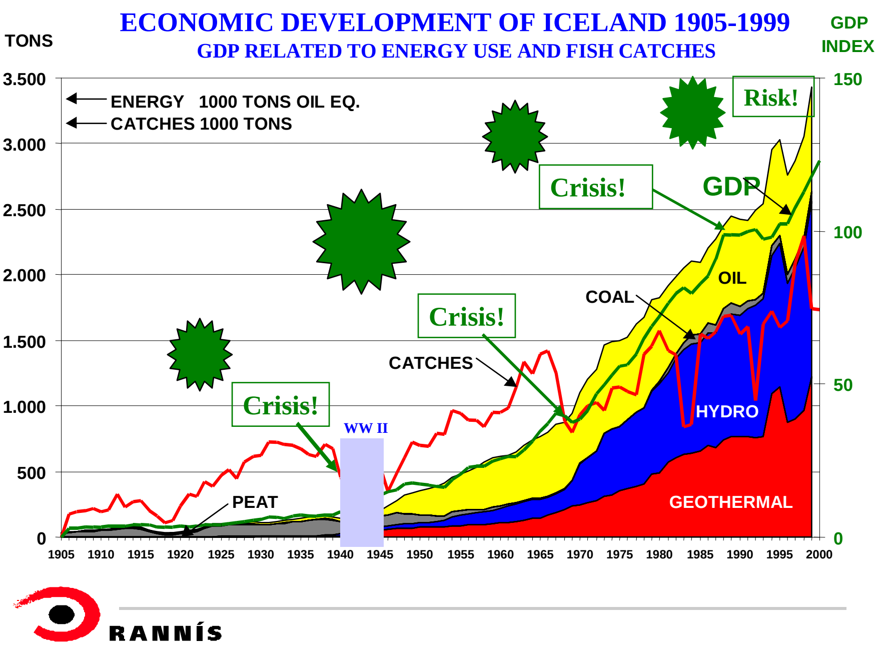
Iceland

By Thorvald Finnbjörnsson

This presentation is partly based on documents published on the Web pages of the Icelandic Government (http://www.raduneyti.is/interpro/stjr/stjr.nsf/pages/english-index).

The policy work of the Research Councils and its development

The Icelandic Research Council RANNÍS was established by law No 61/1994 which entered into force that same year. Still the Council has a longer history, actually much longer than any other Nordic country, as well as many other countries for that matter. The beginning of the work of the council is to be found in the Government Consultant Committee established in 1938 to supervise experimental research of undeveloped natural resources.



In the beginning the work of the Council was coloured by imminent problems related to isolation of the country in case of a war in Europe. The Council was closely connect to the Industry committee of the University of Iceland and even had the same residence. The Council and the committee were located in the first house built on the University campus in 1937, the geology building.

In 1955 the Science Fund was established by recommendation of the Research Council. The fund was under supervision of a board, which had no consultation role towards the Government, but awarded grants to basic research and to further education of scientists. There was at that time no direct formal relation to the Research Council.

In 1987 a new law was passed about the National Research Council and the Research Fund. Simultaneously the Science Council was established, with three divisions with a common board. Oversight and management of the Science Fund was placed under the new Science Council. The Science Council formed a policy for awarding grants from the Science Fund based on scientific requisites, but had nothing to do with the forming of scientific policy. The National Research Council did prioritize some defined research areas for a period of time, e.g. biotechnology, information technology, material technology, environment and aquaculture. In the first three years of the operations of the Research Fund about one third of available funds were utilized to build up knowledge and promote experimental developments in field of biotechnology. Another fund, the Building and Equipment Fund was used to support the building up of facilities in this field. Figure 2 shows some of the overriding goals of the Research Council in 1987.

Figure 2 Research Council Recommendations 1987

The Research Council recommended In 1987

- Increasing R&D investments 10% annually - by state and industry
- Improved condition for innovation - risk capital!lIncreased demands for quality and output of R&D
- Cooperation between public institutes and industry
- Involvement in international R&D cooperation
- Evaluation of results and increased publicity for R&D outcomes

The establishment of the Icelandic Research Council and the ending of the National Research Council

Following the economic stagnation that started in the latter half of the 1980s, an OECD evaluation on science and technology policy in Iceland was asked for. Simultaneously an evaluation of the environment for innovation and entrepreneurship was initiated. This evaluation took place in 1991 and 1992. The evaluators were rather outspoken about the lack of a harmonized government policy and a stimulating environment for innovation based on research and development. It was among other things proposed that a committee of ministers was to be established. The committee should be presided by the Prime Minister, but with the involvement of the business enterprise sector and the scientific society in order to harmonize government action with regards to science and technology policy and support to innovation. Figure 3 shows the main findings of the evaluations of Icelandic STI policies.

Figure 3. The main findings of the review of Icelandic STI policy, 1992

STI Policy review 1992 –Main findings

- Iceland’s strategy unclear
- Lack of political commitment to S&T
- Short-term thinking – Lack of co-ordination
- No forum for setting national priorities
- A new vision needed with science and technology at the core!

This raised political attention!

The advice of the evaluators was not followed at the time, but it was decided to merge the Science Council and The National Research Council into one Council of 11 persons, the Icelandic Research Council. The law on this matter entered into force in the summer of 1994. The members of the Council included representatives from three groups: Universities, research institutions and the business enterprise sector (one-third from each group).

At this time it was also decided to drastically reorganize the business enterprise sector and the system of finance in the country, by privatizing public firms and loosen restrictions in the financial markets. Thus, a substantial renewal and reorganization process started. A well functioning financial market evolved in a rather short time, increasing the availability of risk capital and the will to invest in new ventures, such a those based on technology solutions. A considerable number of new firms were established. Most of the companies with high growth allocated quite a lot of funds to research and the building up of human resources. Economic growth in late nineties partly reflects this development.

Figure 4 shows how the evaluations of Icelandic STI policies were followed up.

Figure 4. Iceland’s response to the 1992 evaluation of the country’s STI policy

OECD Review 1992 the Icelandic Response

- Merged two research councils into one
- Interdepartmental committee on research
- Some increase in funding
- Res. training fund- Research professors
- Financial liberalisation - Risk finance
- Emerging STP mechanism-emerging high-tech economy
- Serious efforts - Concrete Results!

The policy and operations of the Icelandic Research Council, 1994 to 2002

When the new Icelandic Research Council was established in the autumn of 1994 it started to discuss and decide upon policy and operations, which has been characteristic for its work during the period. Three councils have been constituted in the period from 1994 to 2002. They have all worked with the same emphasis, which for a large part has been on organising an inner structure and methods for awarding grants from the funds which is under the control of the Council. It can be stated that the way of operating the Research Funds has gained confidence from the community of researchers. The Council appointed 7 groups of experts to ensure peer review of applications, and also 2 independent grants committees to propose awarding of grants according to the emphasis of the Research Council. The Council has worked towards the goal of ensuring active participation of young scientists and cooperation of research institutes and companies. Participation in foreign research cooperation has been highly regarded in the work of the Council. The mission of the Icelandic Research Council is presented in figure 5.

Figure 5. The mission of the Icelandic Research Council established in 1994

The Mission of the Icelandic Research Council (Established 1994)

To reinforce and underpin the cultural and economic foundation of Icelandic society by promoting vigorous and well co-ordinated - scientific research, technical development and innovation

The Icelandic Research Council's preconditions for the policy making

The present Icelandic research and innovation system is characterised by some seemingly contradictory features:

It is one of the smallest such national systems in the world in absolute terms, but relative to the national economy as measured by GDP it is among the five most resource intensive systems, and it is growing fast.

It attempts to address the full spectrum of modern societal needs and as a result may be one of the most organizationally fragmented systems in the world. However, relative to its size it is one of the most productive systems among OECD countries with regards to scientific output, as measured by publications rate, to international engagement and collaboration, and most surprisingly, recently also to the growth rate in patenting.

The impact of research in the economy is also measurable by the success with harnessing renewable natural resources, meeting natural environmental challenges and more recently, by the rapidly growing share of knowledge based products and services in export figures and in the number of new technology start-ups. Some of the start-ups are not yet readily apparent in trade figures. In particular the heavy investments in biotechnology is still not turning sustainable income and profit to the economy as it is still in the investment phase.

Overall, Icelandic research has played a major role in the economic and social development of the country in the 20th century, and has recently become very important in creating the conditions for continued and sustainable economic growth in the 21st century. A recent survey conducted by the European Commission published in the European Innovation Scoreboard has shown Iceland to be among the leading European Nations in innovation capacity.

How has this been possible with so small and scattered resources?
The answers lies perhaps in several sources of strengths that are cultural and linked to the 'strength of the small' when properly exploited.

Icelanders are on the average a well-educated and still relatively homogenous people with strong common, cultural values. A relatively large number of Icelanders receive an important part of their education abroad, but have a strong preference to return home and eagerly transfer their new knowledge and experience to the country's benefit across the whole spectrum of national endeavours.

The nation is receptive to new and advanced technologies and quickly adopts and adapts them to every day life in Iceland. Many indicators attest to this fact.

There is close proximity between the science system - or the science community - and the users of science and technology. The short lines of communication greatly facilitate pragmatic and cost effective approaches to research problems and issues and the speedy transfer of research results to the users. This last point is becoming an increasingly important feature of the national system of innovation, which greatly serves to strengthen Iceland's competitive position among nations.

Also, Iceland has managed to create a favourable environment for innovation - a veritable living laboratory for research and development related to natural environment and processes, as well as human and technical systems with a great creative and innovative potential.

Last but not least - we should not overlook that over the last 15-20 years Iceland has conducted a consistent science and technology policy which in hindsight has been very successful in the long run and the results of which can now be convincingly documented.

The formal organization of our research system has not changed much over the last 40 years although the functioning and the relative strengths of its various parts have greatly shifted, especially with the emergence of industry based R&D in the 1980s and its dramatic growth in the 1990s. The system appears to be ripe for a major change but that is the subject of another lecture.

Challenges ahead

This list of relative strengths (though with the inherent weakness due to absolute numbers and institutional fragmentation) should not blind us from the challenges that lie ahead. In terms of R&D inputs (in 2001) Iceland is now at the stage coveted by the EC with an overall 3% of GDP spent on research of which nearly 2/3 comes from the private sector economy. The weakness in that figure is that more than half of the industrial inputs come from one company, which has yet to turn profitable.

The government input to R&D is currently close to 1,2% when measured in public performance (partly financed by the private sector and international funds), but about 1,04 % when measured by the funding that comes directly from the national budget paid out of the common coffer. That is already the highest share by OECD comparison.

A very large share of the Government's funding inputs is in the form of direct institutional appropriations. The share of the free competitive funding through the Research Council (RANNÍS) Funds has remained more or less at a constant level over many years. Thus they have been rapidly decreasing in relative terms, and in influence as compared both to total government inputs for R&D and the total national funding of R&D. This is a real cause for concern because RANNÍS has been able to play an important long-term role in creating flexibility by supporting young researchers and leveraging other funds for the financing of forward looking scientific research and technological ventures. With the rapid relative erosion of competitive funds we may be facing a real difficulty in maintaining the quality and creative powers of our R&D system unless the channelling of funds are in part redirected from budget appropriations to competitive project funding.

Past experience

The relative success of our S&T policies since the middle 1980s lies in the strategy adopted and recommended by the Research Council in 1987, after the institution had been given the legal mandate to manage the newly established Research Fund - which later became the Technology Fund. The Council resolved to call for a common effort by industry and public institutions to increase total national investments in R&D by 10% per annum through much strengthened cooperation within the fragmented research system, through increased international R&D cooperation, and through increased demands for the quality and public visibility of research outputs. The Council also called for greatly improved conditions for innovation and availability of risk capital. This overall strategy - and the vision of the future that lies behind it - has been followed by subsequent councils irrespective of repeated reorganizations and changes in membership.

The two major funds used by the Council to support science and technology through competitive project grants are the Science Fund and the Technology Fund. The strategic function of the Science Fund has long been to maintain a minimum level of activity of high quality, basic research across all major disciplines. The Technology Fund has been more instrumental in leveraging more resource intensive investments in applied research and development through cooperation between public and private research actors and through co-funding by different public and private funding organisations. Supplementing and enhancing this strategy through the Buildings and Instruments Fund, also operated by the Council, has also had very positive effects in leveraging the funding of major investments in instruments and facilities. This in particular has enhanced the cooperation between institutes and also attracted other private and public resources into R&D investments. Thus the Science Fund has kept the candles burning but the Technology Fund has been used to light some substantial fires that are now warming the economy and underpinning future growth. This strategy has been quite effective as can be shown through many concrete examples.

In the early days of the Technology Fund (previously Research Fund) in the latter part of the 1980s, the Research Council established technological priorities and encouraged applications in specific fields. This was possible because the Fund was new, and new money is more easily directed to create flexibility and daring investments. The technological priorities in the early years included aquaculture, information and computer technology, biotechnology, materials and energy technology, food and fish processing technology and finally productivity and quality enhancing technology. The major initial investments were in biotechnology and aquaculture but later in food and fish processing technology. The time horizon for the application of this research was considerably longer than might have been expected, especially in biotechnology. One can, however, well argue that the very active area of bio-genomic and pharmacy-medical start-ups in Iceland today was facilitated by these early investments where 1/3 of the Technology Fund resources were used in biotechnology alone. This is also linked up with the support given to biomedical and clinical research by the Science Fund. The same holds for the early investments in computer vision technology and image processing. Those investments have already paid handsomely off in the economy. In recent years the attention has been moving more towards software development, materials and production and construction technology with relatively shorter time horizons and the absence of clearly defined priorities. Only in the so-called specific programme for IT and Environmental Research (1998-2004) have there been clearly defined priorities.

Industry-related policies

In early 2001 the Ministry of Industry and Commerce made public its overall policy objectives and corresponding measures for the coming four years, as follows:

1. Increasing diversity in Icelandic industry and improving its competitiveness
2. Strengthening the Regional Economic Development
3. Increasing the use of domestic energy sources
4. Encouraging competition and strengthening consumer protection

Increasing diversity in Icelandic industry and improving its competitiveness
There have been major changes in Icelandic industries in recent years. Innovation has been stimulated primarily by a more liberal business climate and by rapid progress in science and technology, particularly in information and communications technologies. This has provided Icelandic industry with numerous opportunities to create a variety of jobs in new and demanding areas and enabled it to play an active and profitable role in international trade.

The exploitation of scientific knowledge is becoming steadily more important as a catalyst to economic growth and a prerequisite for improving the competitiveness of business and industry. It is essential that the necessary framework conditions are provided that allow the market forces to deliver their best results. This involves devoting special attention to transmitting knowledge, promoting innovation in all areas, and encouraging the creation of start up enterprises.

The Minister of Industry and Commerce has defined the following measures for achieving the objective of increasing diversity and improving the competitiveness of the Icelandic economy:

- New areas of knowledge, such as the biotechnology industry, will be given special encouragement, in order to develop profitable enterprises in this sector.
- The dissemination of specialized knowledge will be strengthened. This will include measures to improve competitiveness by exploring ways to increase productivity and improve companies' internal structures.
- Public funds will be used to attract financing from private investors for major research projects.
- Studies will be undertaken on ways to improve the tax position of enterprises, including their operations abroad. There will also be investigations of the possibility of using tax incentives to encourage research and development, and of waiving taxes and fees if they damage companies' competitive position.
- A survey will be done of the competitiveness of the Icelandic financial market with a view to strengthen its position in an international context.
- The Icelandic Government will withdraw from its involvement in the banking and insurance sectors that compete with private enterprise.
- Co-operative societies and savings and loan associations will be assisted in transforming themselves into limited companies, and they will be given the opportunity to issue listed shares so that they can compete on an equal footing with other enterprises in today's capital markets.
- The activities of IMPRA (Service Centre for Entrepreneurs and SMEs) will be strengthened by setting up service centres for entrepreneurs and companies in areas outside the capital.
- There will be greater efforts dedicated to providing information on the importance of protecting intellectual property rights in the industrial area.
- There will be a review of legislation concerning intellectual property rights in industry, including the provisions applying to design rights, utility certificates, and employees' inventions.
- Industries based on intellectual property, such as the film and music sectors, will be encouraged. A development fund will be established for the music industry, the main objective being to increase the export value of Icelandic music.
- The Ministry will encourage expansion in the information technology sector by giving companies the opportunity to co-operate on solutions that relate to government services.
- There will be consideration of ways to encourage innovation in business and industry by co-ordinating and combining research activities conducted by government agencies, improving their efficiency, making them more effective, and increasing their success rate.
- Foreign investment will be encouraged, among other things, by providing a favourable legal environment through review and simplification of legislation applying to this area.
- Marketing efforts for foreign investment will be strengthened, placing special emphasis on investment opportunities outside the capital area.
- There will be a concerted effort to increase the number of bilateral investment agreements.

Providing employment opportunities outside the capital area

Traditional forms of production in rural areas will continue to play an important role in the Icelandic economy, even though their percentage of the gross national product will diminish as new industries expand. These sectors will not be able to meet the need for new jobs directly, but can probably promote employment in an indirect manner by serving as a basis for new technologies, especially in the area of biotechnology. To this end, the Minister of Industry and Commerce intends to support efforts in the areas of plant and marine biotechnology as a basis for regional development.

Information and telecommunications technology will heavily influence population developments in areas outside the capital. It will support new enterprises and play an important role in promoting equal employment opportunities and living standards throughout the country.

The Minister of Industry and Commerce has defined the following methods of achieving the aims of promoting new industry and supporting regional development:

- The Institute of Regional Development will take the lead in establishing new enterprises in rural areas by implementing a progressive regional development policy. The Institute will employ men and women with broad experience and knowledge of business, industrial innovation, and the development of new employment opportunities.
- In developing new regional development plans, special attention will be given to measures that must acquire the force of law in order to ensure their implementation.
- Measures to support new employment options will be assessed on the basis of the overall benefits they provide during an extended period of time.
- The relocation of government activities in centres outside the capital will continue, with the objective of providing incentives for further economic development in these areas.
- In co-operation with other parties, the Institute of Regional Development will initiate and support regional initiatives for industrial innovation, knowledge transfer and employment opportunities in accordance with government policy at any given time.
- The Institute of Regional Development will play a leading role in establishing and reinforcing research centres outside the capital area, which will co-operate with universities, government research centres and industry.
- The Institute will take the lead in ensuring that government advisory services serving regional industries are co-ordinated and merged as far as possible.
- Service centres for individuals and companies with innovative ideas will be established in three locations outside the capital.
- A centre for industrial innovation specialising in biotechnology will be established in Akureyri, where emphasis will be placed on the implementation of genetic research on marine resources.
- Another centre will be established in Hvanneyri to work with opportunities that result from genetic research on agricultural resources.
- A competition will be launched for local government authorities involving experimental projects to promote an electronic society.

Increasing the use of domestic power sources

Iceland possesses extensive sources of renewable energy that have been exploited only to a limited degree. However, they are more intensively utilized than anywhere else in the world. Approximately 2/3 of primary power use in the country comes from renewable resources, and their share of electric power production is 99%.

The production and export of aluminium, along with other energy-intensive industry, are actually exports of renewable Icelandic energy. Economic growth in recent years can be attributed largely to foreign investment in renewable energy sources, and experience has shown that industry based on these resources can play a role in halting migration from rural areas.

The Minister of Industry and Commerce considers it essential to increase the utilization of domestic renewable energy resources in order to encourage diversification in industry, create a basis for foreign investment, increase the number of well-paid jobs, and support business and population development in rural areas.

There must be competition in the production and sale of electricity. At the same time, there must be continuing research and development on new sources of energy/means of transmitting energy, to replace dependence on fossil fuels. Environmental concerns must also be taken into account in exploiting domestic energy sources, and there must be attempts to reconcile interests in utilising and conserving natural resources.

The Minister of Industry and Commerce has defined the following means of achieving the aims of increasing use of domestic sources of energy and promoting competition in the energy sector:

- Sufficient basic research should always be available concerning the possibilities of exploiting sources of hydroelectric and geothermal power.
- Location, environmental, and planning studies for potential industrial areas will be done in accordance with plans for energy use.
- Proposals by the Resources Committee for licensing fees for exploiting energy sources will be assessed in view of potential implementation.
- A regulatory framework will be established concerning repayment of government research costs in power development areas.
- Energy will be utilized as close as possible to its point of origin. Negotiations for energy-intensive industrial projects will also include discussion of possibilities for further processing of primary products in Iceland.
- A permanent basis will be established for research on and development of new sources of energy and methods of energy transmission, including those associated with wind energy, hydrogen, and methane gas.
- The role of the National Energy Authority as an advisory and public administrative body will be strengthened, and the division of labour between the Ministry and the Authority will be subjected to review. The Authority's organizational structure will also be reassessed, among other things in view of competitive operation of the research department.
- The first stage of a comprehensive plan for the utilization of hydropower and geothermal power will be concluded before the end of the year 2002. Preliminary conclusions will be utilized, if decisions on exploiting energy sources have to be taken before the plan is complete.

- Environmental concerns will be taken into account and thoroughly considered in the Ministry's examination of energy development plans. The broadest possible public support will be secured for development projects.
- When reviewing energy sector legislation, there will be emphasis on encouraging competition in the production and sale of electric power as well as greater efficiency and security of energy supplies.
- The legal position of energy companies and their customers will be clarified.
- Price equalization, subsidy payments, and other social welfare measures associated with electric power distribution in Iceland will be made more transparent and kept separate from competitive operations.
- Energy companies will be permitted to form subsidiaries and acquire shares in other companies whose primary activities include producing, transmitting, distributing or selling energy, as well as exploit the expertise and equipment they possess for research and development in the areas of energy and energy projects in this country and abroad.
- The regulatory framework for electricity producers and district heating companies will be co-ordinated and simplified. Monitoring of their rate schedules will transferred to the National Energy Authority.
- Contacts will be initiated with foreign firms regarding research on the Icelandic continental shelf on the basis of upcoming legislation concerning the exploration, research, and extraction of fossil fuels.

Encouraging competition and strengthening consumer protection
A competitive environment is essential for modern business, and consumer protection must be assured in every respect. Business performance and a country's standard of living are dependent on the existence of healthy competition, good services, a wide selection of goods, and reasonable prices. It is essential that business be provided with rules of the game that stimulate competition as well as promote efficiency and innovation.

The competitive ability of the financial markets must be improved as much as possible in order to protect the interests of investment company clients. Consumers must also be fully cognizant of their rights.

Government can make an important contribution toward improving service to individuals and companies by initiating electronic business and administration. Both will improve the country's competitive position, and it is essential to provide the proper legal environment for these matters. It is also important to increase public access to official information and promote transparency in government administration.

The Minister of Industry and Commerce has defined the following means of achieving the objectives of promoting competition and improving consumer protection:

- The activities of the Competition Authority will be strengthened, so that it can effectively monitor obstacles to competition, unfair business practices, and market transparency.
- The Ministry will mount an extensive information campaign on consumer legislation in order to inform consumers of their rights.
- The Ministry will promote the dissemination of information for consumers, among other things, via the Internet.

- The public will be informed about the arbitration committees that handle relations between consumers and enterprises so that these bodies can better serve their purpose.
- The legal framework for business will be consolidated through new legislation. The laws governing interest and depreciation will be reviewed and a special securities act passed.
- Legislation concerning the financial markets will be simplified and better adapted to new market conditions, among other things through the addition of legislation concerning investment companies, unit trusts, and insurance contracts.
- The Financial Supervisory Authority will be given the necessary powers to fulfil its monitoring function.
- The legal environment for electronic commerce will be simplified. Special regulations for this sector will be kept to a minimum, and they will be adapted as far as possible to the legal framework of traditional business.
- In its areas of activity, the Ministry will make every effort to adopt electronic administration in order to improve service to the public, thereby reinforcing public confidence in Icelandic governance and strengthening democracy.
- Information technology will be employed in all contacts with the public, with the aim of expanding service and improving efficiency, as well as lowering costs.
- It will be possible to receive 24-hour electronic service via the Ministry's home page to the extent permitted by the most advanced technology available at any given time.
- The public will be assured access to official information on the principle that knowledge acquired by government institutions is public property and should therefore be accessible to the public without charge in open databases.

Recent technological developments have resulted in the continuous growth of knowledge-based industries and services. The five fastest-growing industrial sectors in Iceland over the past few years have been in the information and communication technology (ICT) industry, health technologies (including pharmaceuticals), biotechnology, genetics, biomedical engineering and IT-based equipment production for food processing. After years of effort, developments in these fields have progressed from research to profitable operations. These industries have shown that the boundaries between traditional economic sectors and research institutions are gradually disappearing. The Ministry promotes closer links between industry on one hand, and universities and research institutions on the other, through increased innovation efforts, with the objective that public research funding should yield more economic returns. The primary function of the Icelandic Patent Office is to receive and handle applications for patents, trademarks and design protection.

It could be stated that in the beginning of the 21st century, the Icelandic economy has gone through a reorganization following the global developments, and that it is now based on knowledge and human resources. Science and technological knowledge play a fundamental role in the social and economic development of the country. The importance of science and technological knowledge is supported by the establishment of the new Science and Technology Council, presided by the Prime Minister and with the participation of quite many other ministers and representatives of industry and the science community. This implies the introduction of a new chapter in development of science and theology in Iceland.

Norway

By Johan Hauknes, Olav Wicken, Per Koch and Siri Aanstad

While only a few years ago, research and innovation policies were not part of the general public debate in Norway, at the moment it seems that major politicians can hardly utter a word without mentioning the need for innovation, research and a knowledge based economy. Internationally, the term *innovation policies* appeared as a term for policy concern in the 1970s.

In Norway, the term was generally introduced in 1981 in the report to Government of the Thulin Commission, laying the foundation of major elements of Norwegian technology and innovation policies during the 1980s. A wider set of ideas for a Norwegian innovation policy was presented in three White Papers around 1990. A White Paper on industrial policies in 1989 implied a stronger emphasis on inter-ministerial coordination of innovation policies, a White Paper on regional policies in 1993 summed up a reorientation of regional policies that had been underway over a period of 5-10 years, while a White Paper on research policy in 1993 expanded the perspective of innovation policies by arguing for a stronger systemic approach to innovation, science and technology policies.

Although the term *innovation policy* is fairly recent, innovation policies as functional concerns of public technology and industrial policies are not new. They are an integral part of wider industrial policies, covering areas such as science and technology (S&T) policies, regional policies, education policies, etc. Here, we survey trends in Norwegian innovation policies over the recent period. Although we focus on the trends of the last two decades, the developments will be seen in a broader historical context.

In the decades following the Second World War and up to the late 1970s, Norwegian industrial policies were strongly influenced by the idea that there existed a ‘productivity gap’ or ‘technology gap’ between the USA and Europe. Subsequently, ‘America’ stood out as a model for industrial development, and the dominant strategy was to use state measures to promote the construction of big industry: Large producing units, large organisational units directed towards large scale production. These ‘traditional’ industrial policies were gradually dismantled in the second half of the 1970s, and the 1980s saw several new policy developments.

Central characteristics of innovation policies in this decade are the introduction of the so-called strategic technology areas (hovedinnsatsområdene), based on a set of recommendations from the Thulin Commission; a technology-push orientation; a focus on small and medium sized enterprises (SMEs), and a shift in regional policies from a subsidy oriented policy support to rural areas to an innovation policy focus on the determinants and drivers for regional and local economic development.

Throughout the 1980s, Norwegian industrial policy was characterised by attempts to reconstruct industrial structures – to generate a policy led structural change into ‘progressive’ industries and industrial structures. The development of this specific structure was regarded as necessary to achieve long term economic growth and to be able to compete in an international market. This had in fact been a central strategy since the late 1940s, but the 1980s saw a shift in focus of these strategies. While the emphasis until the late 1970s had been on establishing a corporate structure based on large and financially strong companies competing in international oligopolistic markets, from the 1980s there was a shift towards attempts to develop new industrial sectors based on new, generic and enabling technologies. Technology policy priorities as these were widely shared among industrialised countries and were generally focussed on ICTs, material technology and biotechnology.

The theoretical basis for this shift was the assumption that Western economy was going through a structural transition period characterised as an industrial revolution or change of technological paradigm. Theories of economic development as being stage led, with stages constituted by major technological shifts, as introduced by i.a. Chris Freeman was the foremost argument for a policy arguing that new technologies would create new growth industries which in the long run could become the driving force for wealth and welfare. [118]

The theory became one of the theoretical bases for a strategy for *re-industrialisation* in a period characterised by stagnation in manufacturing industry. The new strategy was based on the idea that future industrial expansion was dependent on success within a few core high-tech technologies.[119] Growth could not be achieved by improving old products and industries, but could only be achieved by developing new products or completely new industries, i.e. by an industry wide process of structural replacement of old industries – often at the time denoted sunset industries – with new, sunrise industries.

In Norway, the main new instrument to increase re-industrialisation of high tech industries was the policy of strategic technology areas. There was broad national consensus behind the idea to increase funding for a few selected technologies - IT, oil and gas, new materials, biotechnology, and fish farming - and to improve the co-ordination between public and private actors - such as companies, universities, R&D institutes, public agencies, etc.- within each technology area.

It was generally accepted that the development of new industries was the outcome of scientific and technological processes. The new industries were defined as ‘science based industries’. R&D became the core element in this industrial strategy, and the main supporters of the strategy were people closely connected to the R&D system. Therefore the R&D system played a central role in the re-industrialisation policy of the 1980s. The policy had two main objectives: To expand the R&D sector (public and private), and to improve the industry-research relationship so that more science-based industries could be established.

The strategic areas policy was successful in the sense that public funding for the selected areas increased, but there is less evidence that the system succeeded in improving co-ordination. Each technology area had different histories and institutional settings, and there were different policy measures used for each area.

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[118] Freeman, C.,Clark, J. and Soete, L., *Unemployment and technical innovation : a study of long waves and economic development*, London: Pinter, 1982

[119] In Norway, this policy was developed over the period 1982-85 and was introduced fully in 1986 in the State Budget for the financial year 1987.

The most complex policy was in the IT sector where a number of initiatives were taken to improve both education, research, production and the use of technology. As an industrial policy, R&D and direct support for companies became a main tool for improving growth and development.[120] In the oil and gas sector also, R&D became an important instrument for the development of a strong national industry directed toward the market for investment goods in the North Sea. In 1978 the Labour government introduced a series of measures to ensure long term supply of inputs to oil and gas exploration and exploitation, most prominent and successful among these being the so-called 'Goodwill agreements'. By procuring R&D and technological services from Norwegian suppliers international oil companies improved their position vis à vis the competition for getting concessions to explore and produce oil and gas from petroleum fields in the North Sea. The Goodwill agreements rapidly increased the size of the research sector of Norway, in particular the institute sector. The main winner was SINTEF in Trondheim which became the largest industrial research institute in Northern Europe. A third policy was used towards the rapidly expanding fish farming industry, where R&D also played an important role. This industry was dependent on a rapidly expanding international food market, and the important aspect was to ensure quality of the product and a low price to the consumer. Public R&D played a crucial role in developing the core technologies for the new sector of the industry.

Gro Harlem Brundtland's second Labour government, in government during 1986-1989, set the goal of increasing public funding of R&D activities by 5 per cent per year in real terms in the Research Policy White paper of 1989.[121] In spite of the rapid increase of R&D activities during the 1980s – partly as a consequence of the introduction of the targeted technology areas, partly as a reflection of the rapid increase up to 1986-87 of S&T activities related to the expansion of offshore petroleum exploitation – the general policy apprehension at the end of the 1980s was that there was a serious underinvestment in Norwegian R&D activities. Several policy priorities were introduced in this period to counter the perceived gap in R&D performance and bring Norwegian R&D performance up to OECD levels in terms of the GERD/GDP-indicator[122].

The outcome of the various policies was that R&D funding grew rapidly through the 1980s (see table 1).

Table 1. R&D funding by sources, private/public 1983-1991 (mill NOK)

Year	**Public sources**	**Other industries**	**Oil companies**	**Other sources**
1983	2924	1824	684	160
1987	4830	3654	1329	299

[120] However, market forces made it impossible to produce the 50 000 new jobs in the sector which promotors of a national IT plan promised in the mid-1980s.
[121] White Paper No 28 (1988-1989) *On research* (*Om forskning*)
[122] No one at the time seemed to notice that in terms of the alternative intensity indicator – GERD/capita or GERD/employment - Norwegian R&D performance was at least comparable with the level of all major trade partners.

1991	6883	4478	902	331

Source: National R&D statistics, Forskningsrådenes samarbeidsutvalg
The numbers indicate the importance of public funding for industrial R&D in Norway throughout the 1980s. Even though industrial funding increased more rapidly than public funding, privately funded R&D still accounted for less than 50% of overall R&D expenditures. The table shows the dramatic structural change that affected the R&D performance during the 1980s; up to 1986 R&D funded by oil and gas companies showed a rapid growth and came to dominate substantial parts of the industrially oriented research system. Following the collapse of the price of crude oil on international markets, the expected profitability of a range of oil and gas fields offshore Norway fell and even turned negative. Hence, R&D related to exploration, construction of production facilities etc. was rapidly scaled down.

In the course of the 1980s, the Norwegian research institutes were criticized for neglecting their industrial role, and the criticism led to a stronger policy stance of 'pushing the institute sector towards the market' – to increase its receptivity to the needs and expectations of the industrial sectors. Though some of the RTD organisations in the national institute sector were formally autonomous - while others were public organisations – they were up to the early 1980s generally seen in functional terms as performing a public task: Producing and supplying the public good of technological knowledge. In 1982 a 'deregulative' priority was set for the institute sector, and the formerly public institutes were devolved from the public sector. The relation to NTNF and other R&D funding agencies were implicitly seen in terms of these agencies buying a service – the performance of specific research activities – on behalf of society, while the commercial viability and competitivity of the institutes were their own responsibility.

The institutes gradually received less direct basic funding from the research council (Norges Teknisk Naturvitenskapelige Forskningsråd, NTNF) and were forced to rely more on income from industrial contractors and partners. Over time the institutes were turned into service institutions for industry more than the politically strategic technology institutions they had been from their establishment. Beyond this increased market exposure of the institute sector, the 'new industry' strategy did not however radically challenge the existing structure of institutions established in the post WW2 period to promote industrialisation.[123]

A striking aspect of the innovation policies of the 1980s is that they grew out of the former R&D industrial based S&T policies. The period saw a specialisation of S&T policies, with an emerging policy focus on the need to direct attention to other issues than the former S&T dominated policies, relying heavily on scientific research as the main vehicle. The former focus on the science base shifted to a view of the criticality of the technology base. There were still links between science and technology, but the

[123] Elsewhere we have denoted the overall process as a KIBSification of the national R&D institutes – a process with evident parallels during the last 20 years in a range of countries.

acknowledgement of essential differences between the two, implied an autonomous technology.

The shift in focus from science to technology made the technology push characteristic of the policies quite dominant. The considerable focus of generic technologies as the base for a re-industrialisation did not necessarily imply a dominant technology push view. But in the specification of this focus that came with the strategic technology areas and the related plans, this became evident. More explicitly expressed, a belief in technology push dynamics was dominant in technology diffusion initiatives of the mid 1980s.

As noted above, the period following World War II had seen a strong orientation towards large enterprises. In the late 1970s and the 1980s this changed, when increased emphasis was put on SMEs. This shift is reflected in the SME White Paper which was published in 1978.[124] The emergence of the innovation policy concept in Norwegian politics at the beginning of the 1980s can be seen against this background. The concomitance of the SME White Paper and the Thulin Commission is probably not coincidental - innovation policy emerged as a policy concern in this period as a consequence of the increased SME focus.

The Thulin Commission was set up by the Labour Government in 1980, and handed in its report in the following year. [125] The terms of reference the Commission was given was to consider the volume, organisation and efficiency of public support to industrial R&D in Norway, with a considerable bias towards assessing the role of public R&D institutions, the structure of public funds and agencies supporting industrial R&D and the role of higher education institutions. The weight given to industry-academy links is clearly reflected in the composition of the five members of the Commission; beside representation of LO, the major trade union organisation in industry, and Norges Industriforbund (the Norwegian Association of Industries), the other two ordinary members were representatives for the major relevant universities (Universitetet i Trondheim and Universitetet i Oslo).

The 1980s also saw a new orientation in regional policies. While focus during the 1960s and 1970s had been on regional distribution and on de-population of rural areas, there was a shift towards a stronger emphasis of regional innovation policy rather than regional distribution policy from the mid 1980s. This shift is evident in the White Paper on regional policies published in 1989.[126]

Another trend, discernable from the late 1970s, was the ideological shift away from using direct state intervention to promote industry towards using market mechanisms. In the immediate post-war period, there had been a substantial distrust in the market system to deliver its welfare benefits. In the area of industrial policy this view was clearly evident in the strong role the Labour governments in the 1950s and 1960s had in

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[124] White Paper No 7 (1977-78), *Small and medium sized industrial firms* (*Små og mellomstore industribedrifter*)
[125] NOU 1981:30A *Research, technological development and industrial innovation* (*Forskning, teknisk utvikling og industriell innovasjon*)
[126] White Paper No 29 (1988-89), *Policies for regional development* (*Politikk for regional utvikling*)

industrial development, also with a substantial and actively used public ownership. The final breakdown of these policies came with the breakdown of the counter-cyclical policies of 1976-78. In fact the new phase is opened by one of the most ardent organisers of public involvement in industrial development, Finn Lied. The Lied Commission of 1979 was a signal of the need of a new market oriented approach,[127] a transition that was brought to fruition with the second Brundtland Government.

Around 1990, an increasing dissatisfaction with the outcomes of both the strategic technology area strategy and the technology push orientation became evident, and the policies of the 1980s were consequently reassessed. Although not representing a radical break with previous policies, the White Paper on industrial policy published in 1989 was felt to signal a new approach.[128] However, the 1990s saw no coherent new strategy for industrial policies, and the decade was in general characterized by a lack of an overriding vision in this policy area. In retrospect, the following trends can be identified: A departure from the 'best industrial structure' strategy (at least in theory), and an orientation towards a broad innovation policy; an increased focus on SMEs; a diffusion of technology strategy; institutional restructuring; and, towards the end of the decade, a stronger emphasis on R&D and innovation policies.

The broader socio-economic background for a new industrial policy of the 1990s was the problems which started by the fall in oil prices 1986, followed by the stock market collapse in 1987, the bankruptcy of the high tech national champions Norsk Data and KV in the years 1987-89, rapid de-industrialisation, increased flow of people from the periphery to the centre, collapse of fishing resources and the fish farming industry, collapse of the national financial system, the highest unemployment figures since WW2 and social problems for large groups. In total, these problems constituted a period defined by politicians as 'crisis'(1986-93). The perceived crisis led to a departure from the 'best industrial structure' orientation we have seen had prevailed in Norwegian industrial policies since the Second World War; old ideas and institutions were abolished, new ones were introduced.

The emphasis on a 'best industrial structure' lost ground to new arguments in favour of broad innovation activities in various parts of the economy. These arguments were based on the view that policies should not be directed towards specific (and radical) structural changes, but to promoting improved productivity and diffusion of new technologies throughout all parts of the economy. Norwegian industrial policy studies submitted by the Aakvaag, Henriksen and (the first) Hervik Commissions - all in the latter half of the 1990s - attached importance to maintaining a broad perspective on innovation.[129]

From the late 1980s, policy documents - for the first time since WW2 - stopped arguing for the importance for growth in manufacturing industry: The 1990s was the decade

[127] NOU 1979:35, *Structural problems and possibilities for growth in Norwegian industry* (*Strukturproblemer og vekstmuligheter i norsk industri*)
[128] White Paper No 53 (1988-1989), *On industrial policy* (*Om næringspolitikk*)
[129] Aakvaag Commission, *The Challenge – Research and innovation for new growth* (*Utfordringen – Forskning og innovasjon for ny vekst*), Report prepared by a commission appointed by the Ministry of Industry and Energy; NOU 1996:23 *Competition, competence and environment* (*Konkurranse, kompetanse og miljø*); NOU 1997:27 *Cost-benefit-anayses* (*Nytte-kostnadsanalyser*)

when Norway entered into a 'post-industrial policy' era in the sense that manufacturing industry was not any longer given political priority relative to other sectors of the economy. Therefore instruments promoting industrialisation should - in theory - not give priority to any specific type of production and industry (in other words, they should be industrially neutral). The general conditions and infrastructure for industry became core elements of industrial policy.

These priorities were clearly expressed in the new industrial strategy defined by the Brundtland government (1986-1989), which consisted of the following elements: [130]

- focus on 'healthy' general economic conditions: inflation, cost level, interest rates, infrastructure (including a more efficient public sector)
- no longer only priority to manufacturing industry
- less direct support to any industry
- de-centralising instruments for industrial policy; local communities and regional authorities responsible for development

The Government also argued that the number of instruments available for industrial policies was rather limited. International agreements like WTO and European Space Agreement (EU) to a large extent defined the instruments which could - formally - be used to shape industrial development. The Government defined the main areas for governmental intervention as:[131]

- R&D, technology and competence development
- capital supply (venture capital)
- infrastructure (transport and communication)

The basic underlying philosophy of the new policy of the late 1980s was to develop a new basis for future welfare by a 'modernisation' of the total economy. The Brundtland Government argued that Norwegian economy had to become less dependent on oil revenues and exports of non-processed products. Norway was too dependent on exports based on natural resources, and in the long term welfare would depend on a successful transformation towards less resource based productions. The government's LTP *(*Long period plans*)* from the late 1980s therefore argued for the need to transform the national economy and ensure a radical structural change. The main difference from the policies of the earlier 1980s was that the Government refused to indicate how the structure of the future economy ought to be.

Looking at the initiatives taken by the governments and Parliament (Stortinget) during the 1990s, there is little doubt that IT/ ICT *de facto* remained a core technology of industrial policies. There are strong indications that many politicians - and other groups and individuals - still followed the 'new industries' strategy from the 1980s and argued that future welfare was dependent on the development of a strong ICT sector in the

[130] White Paper No 53 (1988-1989), *On industrial policy* (*Om næringspolitikk*) is the first White Paper presenting the new policy of the Labour Government.

[131] The three point list is from White Paper No 53 (1988-1989), *On industrial policy* (*Om næringspolitikk*)

economy. During the 1990s, and in particular from 1996, a number of initiatives were taken in Parliament and by the governments to support the development of IT and promote increased ICT production. The establishment by the Jagland Government (1996-97) of an IT department and the proposal for a broad national ICT plan indicate the wide belief that this technology represented modernity and 'the future' for large parts of the political establishment.

The new strategy of the late 1980s was to a large extent in line with the ideas promoted by 'the small-is-beautiful' supporters. They argued for less direct state intervention and for improvement of the general conditions for SMEs. In addition, they supported the instruments which during the inter war period supported a rapid de-centralisation of industry. The most important of these were instruments for diffusion of technology and of best practices in the company. What can be called a *diffusion of technology strategy* gained political support from the late 1980s and early 1990s, and a number of new instruments for promoting diffusion of best practices and technology were introduced.

The restructuring of the policy instruments directed towards diffusion of technologies was part of a broader international trend with a number of policy measures undertaken in particularly in the USA. The old state owned diffusion institution, STI (Statens Teknologiske Institutt), was transformed into a private foundation with the objective to promote knowledge on technology and management for SMEs, and changed name to TI (Teknologisk Institutt) in 1988. A new Service Office for industry for Northern Norway (Veiledningstjenesten for Nord-Norge, VINN) had parallel functions to TI but only focused on the special needs of the northern parts of the country. Similar services were offered by BRT (Bedriftenes Rådgivingstjeneste), established 1991, consisting of 18 advisory companies offering consultancy services to SMEs. Information on new technologies was also provided by Norges Industriattacher which is a part of the TI system, and on design by Norsk Designråd.

Also, the funding agencies and R&D institutions that had been a central part of S&T policies in the post-war period increasingly came under scrutiny from the late 1980s. In 1990, the Grøholt Commission was initiated, and its conclusions led to the disbanding of the former five research councils and the establishment of an intended single body research council, The Research Council of Norway (RCN, Norges forskningsråd), in 1993.[132]

Norges forskningsråd was given a strengthened and formalised agenda that went beyond the role as a classical research council *cum* funding agency. Besides being a research council in the established sense, the new body was given the explicit task of being a central policy formulating and advising body for national R&D and innovation policies. The formalisation of this independent policy making role and the expectations linked to it is probably the main aspect that explains the establishment of the new research council; it grows directly out of the criticism of the former research council structure handling of national coordination and organisation of the strategic S&T priorities during the 1980s, viz. in the organisation of the strategic technology areas.

[132] NOU 1991:24 *Organization for totality and diversity in Norwegian research* (*Organisering for helhet og mangfold i norsk forskning*)

The 1990s also saw the establishment of the Norwegian Industrial and Regional Development Fund (Statens Nærings- og Distriktsutviklingsfond, SND). Like RCN, SND was established as a re-organisation and re-orientation of several pre-existing institutions, including the Regional Development Fund (Distriktenes Utbyggingsfond), The SME Fund (Småbedriftsfondet) and the Industrial Fund (Industrifondet). The initiative came from several commissions involved in evaluating the Norwegian credit market policies and groupings advocating a reorganization and simplification of the instrument portfolio.[133] SND's main task was to stimulate industrial development, by contributing to the development, modernization and readjustment of Norwegian industry in general, and by promoting initiatives which would secure lasting and profitable regional employment.

The new emphasis on regional innovation policy - rather than the traditional regional distribution policy - from the mid 1980s, was upheld in the 1990s. This is evident i.a. from the explicit consideration of 'regional policies for metropolitan areas', with a White Paper launched in 1991.[134] With 1993 and 1997 White Papers on regional policy these aspects were integrated into a perspective that highlighted the policy need of considering the 'broad' and the 'narrow' regional policy. [135] The distinction was used to argue that to make regional policy in the narrow sense efficient, an explicit assessment and regulation of the broad regional policy was necessary. This led to reorganisations within the relevant ministry, with the responsibility for the assessment of broad regional policies being institutionalised within the ministry. The point to note here is that this involves a supervisory role from the perspective of regional innovation policies towards the regional implications of innovation policies as formulated in other ministries.

In the latter half of the 1990s the importance of financial strength of large companies once more became a political matter. Globalisation - and in particularly the increased importance of multinational corporations (MNCs) in the global economy - raised the question of how Norwegian companies could compete with large global multinationals in increasingly more open international capital and goods markets. The sale of the most successful Norwegian company of the early 1990s, Nycomed, and the national symbol company Freia (chocolates) to foreign competitors, as well as Kværner's decision to move its headquarter to London, triggered a discussion on how to keep national control of the more important companies as well as being an attractive economy for MNCs. The argument for national control was the need for keeping knowledge production and R&D in the country.

The political problem on the agenda in the middle of the 1990s was therefore partly to develop financially strong national companies and ownership. The State had become a major owner in Norwegian industry, controlling both big manufacturing industry (Statoil, Norsk Hydro), the bank sector (the largest commercial banks) and high tech institutions (Telenor). State ownership could be used to make sure that important industrial companies remained Norwegian. In addition the government returned to the

[133] e.g. the Steigum Commission and the Kleppe Commission
[134] White Paper No 17 (1991-92), *Norway needs its big cities* (*Norge trenger storbyene*)
[135] White Paper No 33 (1992-1993), *City and countryside side by side. On regional development* (*By og land hand i hand. Om regional utvikling*); White Paper No 31 (1996-97), *On district and regional policies* (*Om distrikts- og regionalpolitikken*)

old policy of selecting some 'national champions' which could be a collaborator in developing strong national ownership.

The politically most interesting case was K.I. Røkke's role in developing an integrated company in fishing and fish processing industry in collaboration with SND from 1993. Røkke also became an important player in shipbuilding and investments products for the oil sector as he became a majority owner of the Aker company in 1996. Another example of new 'national champions' is IT Fornebu/ Norsk Investorforum where Fred Olsen, the former owner of Aker, followed a long tradition of his old company to enter into agreements with the Government to support the Government's strategy. However, we may argue that there were not many industrial owners in the late 1990s who were willing to play the role as a 'national champions'.

As mentioned earlier, the ideas of an innovation policy was first presented in Norway in a White Paper on research policy in 1993.[136] Although the document introduced innovation and systems theory to a larger audience and stressed the need for larger R&D investments, it did not give birth to a larger debate. Neither did it lead to any substantial increase in national investments in R&D.

Towards the end of the 1990s, however, the interest in innovation and R&D policies seemed to be stronger. A White Paper on research policy published in 1999 was completely structured around innovation theory. [137] The Research Council became the institutional stronghold for the theory and was supported by the Research Department at the Ministry of Education and partly by the research department of the Ministry of Industry and Trade. In addition there were individuals in ministries and in other agencies working on industrial policy for developing a new strategy based on innovation theory. I 1999 the Research Council succeeded in creating an alliance with the Norwegian Industrial and Regional Development Fund (SND) and the Norwegian Export Council (Eksportrådet) to promote the idea that Norway needed a new industrial strategy and that this strategy should be based on innovation theory.

The 1999 White Paper on research mentioned above - entitled *Research at the beginning of a new era* - was published by the Bondevik I Government (1997-2000). The White Paper contained an analysis of the whole Norwegian knowledge system, from university and college research to industrial innovation activities. It recommended that Norwegian national R&D funding should reach the OECD average, measured as a proportion of GDP, in the course of five years. Also, it proposed the establishment of a research and innovation fund. It further argued that a main priority in the use of public funds should be the strengthening of long-term fundamental research, and priority should be given to increased research commitment in the fields of marine research; information and communication technology; medical and health-care research; and research in the area of intersection between energy and the environment.

The White Paper was well received by the various research institutions, by industry as well as by the opposition in Parliament. Parliament did, however, emphasize that the national goal of reaching the OECD-average as regards the R&D proportion of the GDP

[136] White Paper No 36 (1992-93) *Research for the community* (*Forskning for fellesskapet*)
[137] White Paper No 39 (1998-1999), *Research at the beginning of a new era* (*Forskning ved et tidsskille*)

must be considered a minimum.[138] It explicitly asked the Government to increase the public investments in basic science in the universities and colleges ‘substantially’. The capital of the Fund for Research and Innovation - which was established in July 1999 - should also be increased ‘substantially’.

In March 2000, the Hervik Commission handed in its report.[139] The Commission had been appointed by the Bondevik I Government to consider policy measures that could stimulate an increase in private investments in R&D. The report proposed that companies investing in certain types of R&D projects should get 25 per cent of the expenses covered by the State. While the majority of the Commission argued that this should be given as a tax credit, the minority was in favour of it being given as direct financial support. Further, the Commission recommended that the number of doctorate recruits should be increased substantially in the sector of higher education in order to support the demand for new researchers. It also underlined the need for investments in new scientific equipment in this sector. Moreover, the report suggested an increase in the public investments in R&D programmes targeting the business enterprise sector by 500 million kroner. It also recommended an increase in strategic university programmes for basic science and in SND’s high-risk loans.

Two months after the Hervik Commision, the Commission of Higher Education, led by Professor Ole Danbolt Mjøs**,** delivered its report on Norwegian universities and colleges.[140] This Commission had been given a very broad mandate, covering most issues concerning higher education. The report included some very radical and controversial proposals, which led to much debate.

The Commission wanted to give the state universities and colleges more independence and responsibility. The Commission’s majority wanted to organize them as independent legal entities fully owned by the state. A reform along these lines would mean that the Ministry of Education and Research no longer could instruct the management of the institutions directly, but would normally have to go through the board of the institutions.

The Commission stressed the need for change in the university and college sector, pointing to the internationalisation of higher education, new forms of teaching and learning, the increasing complexity of the knowledge system, and the need for high quality learning environments, research and development. It proposed a new degree system in Norwegian higher education - one more similar to the Anglo-Saxon model. The new system should, according to the Commission, be implemented in as many disciplines and professions as possible

Also, it was emphasized that the goal of reaching the OECD-average as regards national R&D investments should be the first step towards a higher goal: Norway should invest as much in R&D as its Nordic neighbours, Sweden, Finland and Denmark. The public

[138] Parliamentary Committee Proposal No 110 (1999-2000)
[139] NOU 2000:7, *A New Start at Innovation - Analysis of instruments for increasing private investments in R&D* (*Ny giv for nyskaping – Vurdering av tiltak for økt FoU i næringslivet*)
[140] NOU 2000:14, *Freedom and responsibility – on higher education and research in Norway* (*Frihet med ansvar - Om høgre utdanning i Norge*)

support to basic science should be increased considerably and the Fund for Research and Innovation should reach the size of 20 billion Norwegian kroner.

The Mjøs Commission's proposals regarding the organisation of higher education led to an intense debate on the future of universities and colleges. The debate showed a clear divide in the understanding of the traditional higher education system. The supporters of the report argued that a radical reform in Norwegian higher education would be necessary in order to meet the challenges posed by new information and communication technologies, new private educational facilities and new technologies. The opponents argued that major parts of the present system must be preserved in order to defend academic freedom and curiosity driven basic research.

The Hervik and Mjøs Commissions both underlined the need for an increase in public investments in R&D. Many of the participants in the debate regarding the need for a general strengthening of the national investments in R&D, have pointed to concepts like 'the new economy', 'the knowledge society' or 'the information society, feeling that Norway ought to invest more in high-tech and ICT. Others have claimed that the State invests too little in basic research at the universities. The debate has shown, however, that few have had any clear concept of what is meant by a 'knowledge society'. Apart form the call for larger public spending on R&D it remains unclear how Norway is going to reach the national goal of an R&D spending (as measured as part of GDP) at the level of the OECD average.

In 2000, a new Labour government, led by Jens Stoltenberg, entered office. The Stoltenberg Government (2000-2001) did not signal any major change of course from the strategy suggested by the outgoing centrist government, and the plans of the Bondevik I Government to increase investments in Norwegian research were upheld. The Government's first regular budget proposal led to an increase in R&D investments. The increase was however not in any way sufficient if one is to reach the national goal of reaching the OECD average within 2005, and the budget was criticized for being too restrained as regards public investments in R&D.

The Stoltenberg Government followed up the recommendations of the Hervik Commission - though rather modestly - by introducing the FUNN measure, which gave public financial support to companies buying research and development from the universities, colleges and research institutes. The proposal of the Commission to give tax deductions for R&D investments was however rejected.

Several documents of relevance for R&D and innovation policies were published under the Labour Government. A White Paper on higher education followed up the controversial Mjøs Commission report.[141] The strong resistance to this report felt in the universities and colleges had taken its toll, and the White Paper was in no way as radical as the Green Paper. However, the Government wanted to ensure the institutions more freedom, and supported the idea of an 'Anglo-Saxon' degree structure.

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[141] White Paper No 27 (2000-2001), *Fulfil your duty - Ask for your rights. Quality reform in higher education* (*Gjør din plikt - krev din rett, Kvalitetsreform av høyere utdanning*)

At the heart of the White Paper was the idea that we presently live in a 'knowledge based society', and the goal for Norway to become a leading 'knowledge nation' was upheld. Among the actions presented in the document were: More academic and economic freedom for the institutions; a new degree structure; a new content-reform; a new grade-scale common for all disciplines and institutions; a new system of institutional funding; expanded possibilities for institutional profiling (focus); and improved, simplified and result-oriented student grants.

Another central document presented by the Stoltenberg Government was a White Paper on regional affairs.[142] The main policy objective of this White Paper was to secure a balanced development as regards population settlement and industrial growth. Much emphasis was put on the need for innovative and competitive companies in the regions. It was argued that more of the funding should be distributed according to the population density of the various regions. The changes in policies were summed up by saying that there should be a shift as regards focus, organisation and measures from municipalities to regions; from individual measures to more coherent need; from individual companies to a common effort for regional development; from sector-oriented measures to co-ordinated efforts; and from centralised regulations to more regional freedom.

A White Paper on the Norwegian Industrial and Regional Development Fund (SND) was also published.[143] In the introduction, it was pointed to new challenges in the use of knowledge, research and innovation. The technological development and the increasing globalisation was said to open up for new solutions in all parts of industry. The Government's overall objective was to develop framework conditions for profitable industrial development in all parts of the country. In order to achieve this, the White Paper argued that regional resources must be mobilized and connected to relevant competence institutions and networks. The innovation systems, consisting of entrepreneurs, companies, research and finance institutions, advisers and others, must contribute to high levels of innovation.

The White Paper stressed that industrial policy is knowledge policy, and that competences cannot be understood separately from other framework conditions underpinning wealth creation. This together with the ongoing internationalisation, the White Paper maintained, lead to a demand for a more coherent industry policy. It also argued that industry policy must be co-ordinated with general economic policies as well as regional-, R&D, fishery-oriented-, agricultural- and environmental policies.

The White Paper further proposed that SND should co-operate with the Research Council of Norway and other organisations in order to ensure that the regional SND offices become competent and effective gateways to industry oriented policy instruments. SND should be able to adapt its instruments to regional differences and the needs of the individual enterprises. Within a fixed budget SND would be given freedom to decide whether the institution should offer grants, loan guarantees or a combination of these. Moreover, SND should work more proactively vis-à-vis firms and innovation

[142] White Paper No 34 (2000-2001), *On district and regional policies* (*Om distrikts- og regionalpolitikken*)
[143] White Paper No 36 (2000-2001), *SND: New efforts, new growth, new industry* (*SND: Ny giv, ny vekst, nytt næringsliv*)

and competence institutions. The organization should use its competence and networks to bring companies together. The White Paper proposed a new measure for entrepreneurs, consisting of grants as well as loans, and maintained that SND is to give priority to entrepreneurs that use most of their time on the supported project.

In 2000, the Stoltenberg Government appointed a Commission to evaluate measures for increasing the commercialization of university and college research. The Commission, which was led by Jan Fridthjof Bernt, presented its report on March 28th 2001.[144] The Commission believed that the universities and colleges must consider commercialization as part of their activities. However, the researchers must have the freedom to choose their research topic. The commercialization process should involve the institution, the research unit as well as the researcher or the group of researchers.

The majority of the Commission believed that the researcher ought to retain the full property rights of an invention. These members argued that this would be necessary in order to defend the freedom of scientific research. A minority preferred to transfer this right to the institution, arguing that the institution needs this in order to promote commercialisation in an efficient way.

The Commission as a whole believed that the income following from such commercialization should be split between the researcher, the institution and the research units. Commercialization can be strengthened, it was argued, by the use of various incentives, practical organizational changes and information on the importance of such activities. The institutions should develop relevant strategies and establish ‘innovation centres’ with professional advisers, internally or externally.

In the spring of 2001, Parliament debated the Labour Government’s White Paper on higher education. There was agreement as regards the need for a quality reform in the university and college sector. Nevertheless, Parliament made several changes in the government proposal, and underlined the need for an increase in funding. Parliament also asked the Government to forward a proposal on tax deductions on industrial R&D investments. The Labour Government was however reluctant to do so. It would rather use the aforementioned FUNN support measure for companies commissioning research from universities, colleges and research institutes

2001 also saw the presentation of the Stoltenberg Government’s so-called Progression Plan (Opptrappingsplan) for the national R&D effort.[145] In the plan the Government underlined that research had been - and should remain - a ‘strong priority area’. The Government’s objective was to reach the OECD average regarding R&D investments as a proportion of GDP *as a minimum*.

In the fall of the same year, the Stoltenberg Government was replaced by the Bondevik II Government - a coalition government of the Conservative Party, the Christian People’s Party, and the Liberal Party, which at the time of writing (March 2003) is still in office. Among the main policy issues presented in the so-called ‘Government platform’ of the three coalition parties, were that Norwegian R&D investments should

[144] NOU 2001:11 *From insight to industry* (*Fra innsikt til industri*)
[145] Parliamentary Bill No 85 (2000-2001)

reach at least the OECD-average within 2005; that the institutions of higher education should decide their own internal governing structure; that there should be tax deductions for industrial R&D investments; that the knowledge transfer between universities/colleges and industry should be strengthened; and that SND should sell its investment company (SND Invest).

Whether the change of Government has actually led to a change in innovation policy is a matter of debate, as the various ministries seem to give different signals. The general trend seems to be a shift towards a greater reliance on indirect policy measure (tax deductions). This view is supported by the fact that the new Government started its term by cutting in the innovation and industry oriented R&D budgets of the Research Council and The Norwegian Industrial and Regional Development Fund (SND), whilst replacing the aforementioned FUNN measure with the tax deduction scheme, SkatteFUNN.

Certainly, since the Bondevik II Government came to power, Norway has been going through a turbulent time in the field of innovation policies. The new Government has ambitions towards altering more than the present palette of innovation policy instruments. It will also reform the educational system, alter the division of labour between the State and the counties, and include new policy areas into innovation policy development.

The new Minister of Education and Research reintroduced some of the more controversial proposals from the Mjøs Commission on higher education, and implemented a quality reform for universities and colleges. The Government has for instance introduced a new degree structure consisting of three levels: Bachelor (three years), master (two years) and Ph.D (three years). The studies will be shorter compared to the old system. The new degrees are based on the Anglo-Saxon system, and the institutions will use the English terms.

On January 1st 2003 the Ministry of Education and Research established a new national organisation for quality in education: NOKUT (Nasjonalt organ for kvalitet i utdanningen). This organisation is now main authority as regards the accreditation and approval of institutions and educations.

The Minister of Education and Research has - as the leader of the Cabinet's Research Committee (Regjeringens forskningsutvalg) - initiated a cross-ministerial process that may lead to a new 'holistic' Norwegian innovation policy (*En helhetlig innovasjonspolitikk* – HIP). The responsibility for this process has now been transferred to the Ministry of Trade and Industry, which is expected to present an action plan together with the national budget presented in October 2003. The idea is to include all ministries in innovation policy development. The plan is related to the EU concept of a third generation innovation policy that goes beyond the traditional innovation policy areas of industry, R&D and regional policies, and includes areas that indirectly influence the innovative capabilities of firms.[146]

[146] Lengrand, Louis *et al*, *Innovation Tomorrow, Innovation Policy and the Regulatory Framwork: Making Innovation an Integral Part of the Broader Structural Agenda*, DG Enterprise, October 2002

The action plan on a holistic innovation policy will discuss the knowledge base for this new innovation policy approach, contain concrete policy proposals in important areas and establish clear policy objectives. The action plan will focus on five so-called 'focus areas'.[147]

- General framework conditions
- Knowledge and competence
- Entrepreneurship and the establishment of new companies
- Research, development and commercialisation
- Infrastructure (presumably physical infrastructure)

It is interesting to note the way the work is organized. Formally the work is led by a ministerial committee chaired by the Minister of Industry and Trade. The other members of this committee are the Minister of Education and Research, the Minister of Local Government and Regional Affairs, The Minister of Oil and Energy and the Minister of Agriculture. On an informal basis, however, much of the work is co-ordinated by a group of state secretaries (deputy ministers), originally state secretaries from the Ministry of Education and Research, Industry and Trade and Local Government and Regional Affairs. It seems that the new policy has been initiated due to the personal interest of some of these state secretaries. This is therefore not an initiative taken by the bureaucracy. There are several working groups of civil servants focusing on various aspects of the new policy.

The Ministry of Trade and Industry also initiated an internal evaluation of the structure of business-oriented policy instruments and institutions. Among the topics discussed has been the future organization of The Norwegian Industrial and Regional Development Fund, SND, The Industrial Development Corporation of Norway (SIVA), the Trade Council of Norway, the industry oriented parts of the Research Council of Norway, and more. The policy makers have also been looking into the mix of indirect and direct policy instruments and measures. This has been a so-called open process, where the Ministry has asked various relevant public institutions, counties, companies and industrial organisations to voice their opinion on the future of the Norwegian industry policy instruments. All these contributions have been published on the Net.[148]

A proposition based on the Ministry of Trade and Industry's evaluation of the structure of business-oriented policy instruments and institutions, was presented to Parliament on March 28th 2003.[149] According to this document, the main goal of the innovation policy instrument system should be to contribute to more innovation in industry all over the country, and particular focus should be on research and competence development; the idea, development and commercialization phases; and internationalization. Also, it is proposed that a new organization is to be established, which is to be given the responsibility for the measures administered by The Norwegian Government Consultative Office for Inventors, SVO (Statens veiledningskontor for oppfinnere), the Norwegian Trade Council (Norges Eksportråd), and the Norwegian Industrial and

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[147] http://www.odin.dep.no/nhd/norsk/024071-990018/index-dok000-b-n-a.html
[148] http://www.odin.dep.no/nhd/norsk/p30000694/p30003208/024091-990021/index-dok000-b-n-a.html
[149] White Paper No 51 (2002-2003), *Instruments for an innovative and creative industry* (*Virkemidler for et innovativt og nyskapende næringsliv*)

Regional Development Fund, SND. The proposal is clearly motivated by an ambition to unite the most important institutions targeting near market innovation and entrepreneurship. It is suggested that the new organization should be organized as a 'special law company' (særlovselskap) – i.e. a state company with special authority, and that it should take over some of the innovation oriented policy measures administered by the Research Council of Norway.

The present Ministry of Regional and Local affairs is very much involved in the development of policy instruments targeting regional innovation. The Ministry is in favour of giving counties more responsibility for policy measures targeting regions and districts. This will include giving the county administrators more influence over the administration and allocation of innovation policy measures and funds.

Another development in regional policy is the establishment by SND of a new program for regional innovation, which is to stimulate the development of regional innovation systems and industrial clusters. The basic idea is that regional conditions are of great importance to innovation and value creation. By promoting regional co-operation between companies, R&D environments and innovation policy institutions, the programme is to contribute to increased growth and international competitiveness at firm level

In the early fall of 2002, the Bondevik II Government announced a reorganization of the Research Council of Norway. The current six divisions will be replaced by three: A Division of Disciplinary Development, a Division of Innovation and User-initiated R&D and a Division for Strategic Efforts. The background for this reorganization is an evaluation of RCN made by Technopolis. The evaluators were in part very critical towards the activities of the institution, arguing that the RCN has not been able to coordinate Norwegian research as originally planned in 1993, when the former research councils were united in this new institution. This can partly be explained by a lack of funding and coordination on the ministerial level, the evaluators explain, but the Research Council itself has also found it hard to coordinate their own internal activities. The main report argues that 'the experiment' with one council should continue, although with a different internal structure.

The 2002 October national budget proposal from the Government reaffirms the goal of reaching the OECD-average as regards R&D investments as a proportion of GDP.[150] However, it underlines that industry must take care of 60 per cent of this increase. This is a rather unrealistic objective, and the Prime Minister recently commented that although the objective is clear, Norway might not reach this goal within the deadline of 2005.[151]

That being said, the Government has shown a clear willingness to do its part to achieve an increase in national R&D investments. Although the Norwegian economy is strong and the national surplus is large, the Government has in fact small room for manoeuvring. Most of the budget is already committed to regular expenses as health and

[150] St.prp. nr. 1 (2002 – 2003), see for instance the proposition for the Ministry of Education and Research, http://odin.dep.no/ufd/norsk/publ/stprp/045001-030004/index-dok000-b-n-a.html
[151] Interview Aftenposten.

social services. Moreover, this being a minority coalition government, it will not only have to make internal compromises, it must also negotiate with a rather aggressive opposition. All parties in Parliament support an increase in R&D investments, however, meaning there is a fair chance that the new investments will go through.

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Lengrand, Louis *et al*, *Innovation Tomorrow, Innovation Policy and the Regulatory Framwork: Making Innovation an Integral Part of the Broader Structural Agenda*, DG Enterprise, October 2002

NOU 1979:35 *Structural problems and possibilities for growth in Norwegian industry* (*Strukturproblemer og vekstmuligheter i norsk industri*)

NOU 1981:30A *Research, technological development and industrial innovation* (*Forskning, teknisk utvikling og industriell innovasjon*)

NOU 1991:24 *Organization for totality and diversity in Norwegian research* (*Organisering for helhet og mangfold i norsk forskning*)

NOU 1996:23 *Competition, competence and environment* (*Konkurranse, kompetanse og miljø*)

NOU 1997:27 *Cost-benefit-anayses* (*Nytte-kostnadsanalyser*)

NOU 2000:7 A *New Start at Innovation - Analysis of instruments for increasing private investments in R&D* (*Ny giv for nyskaping – Vurdering av tiltak for økt FoU i næringslivet*)

NOU 2000:14 *Freedom and responsibility – on higher education and research in Norway* (*Frihet med ansvar - Om høgre utdanning i Norge*)

NOU 2001:11 *From insight to industry* (*Fra innsikt til industri*)

Parliamentary Bill No 85 (2000-2001)

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White Paper No 27 (2000-2001), *Fulfil your duty - Ask for your rights. Quality reform in higher education* (*Gjør din plikt - krev din rett, Kvalitetsreform av høyere utdanning*)

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White Paper No 51 (2002-2003), *Instruments for an innovative and creative industry* (*Virkemidler for et innovativt og nyskapende næringsliv*)

Sweden

By Staffan Larsson, Lennart Norgren and Jennie Granat

In Sweden the concept of innovation policy, i.e. fostering economic growth and competitive power of national industry by creating favorable conditions for innovative activities, entered the general, political rhetoric in the 1990s. The concept of innovation systems in general, and national innovation systems in particular, began to spread in the policy debate and in policy thinking in the late 90s. At the end of the 90s a policy reformulation took place against the background of comparatively slow economic growth and increasing regional economic imbalances. The Government presented two major strategies for turning these trends. The first one focused on creating increased economic growth by increasing the co-ordination of industrial and research policies, which manifested itself in a considerable reorganisation of the public research funding structure in January 2001. The second strategy for correcting regional imbalances meant implementing so called ‘regional growth agreements’.

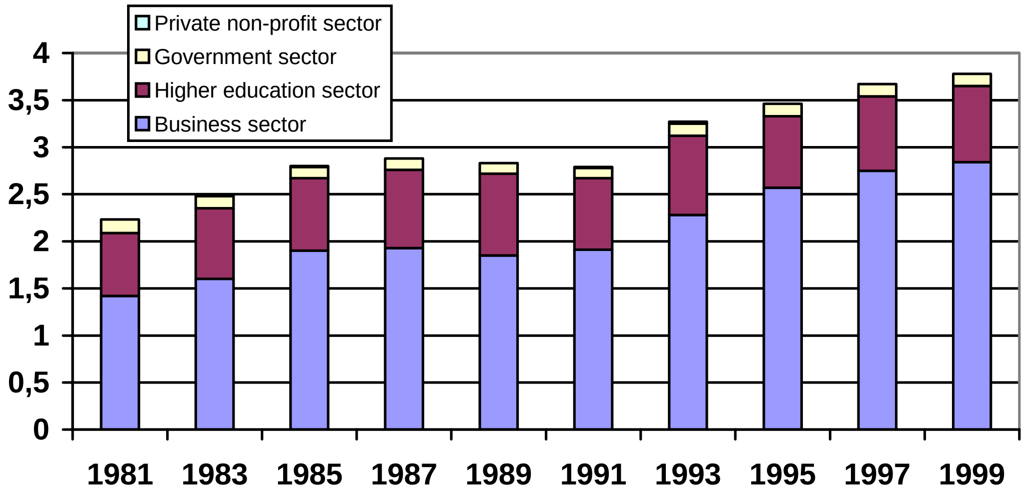
In the following we try to trace the roots of the current Swedish ‘innovation policy’ by focusing on the changes in research policy and industrial policy since 1980.

Although it was in the 90s that the concept of innovation policy began to be used, policy measures aiming at influencing innovation performance by improving the conditions for innovative activities have been important for a longer time. These measures have to a large extent been directed towards technology development and research in universities. The reason for this is the rather unique Swedish pattern with a quite small research institute sector in international comparison. A long-standing principle has been that publicly funded research as far as possible should be carried out in universities and less in research institutes. Hence, the main actors in the production of knowledge, technology and innovations have been universities and enterprises. R&D activities have also been concentrated to the business enterprise sector and the higher education sector, i.e. universities. The enterprise sector accounted for around 75 per cent of R&D expenditures in 1999. The corresponding figure for universities was 22 per cent (see figure 1 next page)

The ‘innovation policies’ directed towards university research have focused on two issues. The first issue concerns the direction of research and joint industry-university programs and the second on the commercialisation of research findings. Governments have for several decades tried to influence the direction of research in universities towards specific technologies and the demands of industry and society. In the 1970s commercialisation of research findings was introduced as a policy issue at the Ministry of Industry. In the 1980s new measures aiming at promoting commercialisation of research were introduced.

The two policy fields that have primarily been involved in the evolution of a Swedish innovation policy are research policy and industrial policy. Industrial policy, however, involves many other issues than innovation. In this paper we limit the scope of industrial policy to technology policy and innovative activities, i.e. measures aiming at steering the direction of research towards specific technologies and at increasing commercialisation of research.

Figure 1. R&D expenditures in Sweden in sectors as a percentage of GDP, 1981-1999



Source: Statistics Sweden

The 1980s – first steps towards an innovation policy

'Innovation policy' has developed in Sweden since the 70s, in the beginning primarily with focus on how to make public funded research at universities useful to society, i.e. not how to make industry more innovative. Research policy, or the government organisation for steering and financing research, in the 1960s and 70s was characterised by sectorisation, i.e. a growing share of public research funding was distributed by other ministries than the ministry responsible for research issues, i.e. the Ministry of Education. Most of the ministries established their own research priorities on the basis of needs and demands of their sectors of responsibility. Some ministries had agencies with the objective to handle industry-oriented research funding, for instance the agency STU (Swedish Board for Technical Development) under the Ministry of Industry. The Ministry of Education was responsible for distributing faculty bloc grants and funds to research councils. Two models of public funding and steering of research existed in parallel: The research council model, where scientists decided the direction of research, and the sector model, where societal and scientific interest in collaboration decided the direction of research.[152]

A recurrent question during the 1980s and 1990s was which of the two steering models for research, the sector model or the research council model, is most appropriate for inducing innovation, industrial renewal and economic growth?

In the 1970s, as mentioned, the sector model gained ground at the expense of the research council model. The increase in public research funding was primarily distributed to ministries and agencies that prioritised research from the point of view of societal needs and objectives. The predominating doctrine was that the Government should steer the direction of research carried out in universities through sector research in order to make research useful for society. In the 1980s this doctrine began to be

[152] Persson Bo, *Motsträviga myndigheter? Sektorsforskning och politisk styrning under 1980-talet*, Stockholm: ISTER, 2001

questioned. Research bills presented by the Government in the 80s dealt with the 'right' balance between basic and applied research, or in other terms, between the research council model and the sector model. It was argued that the sector model emphasised applied and short-term research. Basic research tended to get too little funding, which in the long run would undermine applied research.[153]

In the Research Bill of 1982 it was stated that engineering sciences were to be geared towards fields that were prioritised in industrial policy. In the following Research Bill of 1984 increased funding of basic sciences was proposed, i.e. research motivated not by the needs of society but by scientific search for new knowledge. The research councils were given increased resources.[154]

In the middle of the 1980s the debate heated concerning the volume and quality of research funded by agencies and ministries, i.e. the sector model was questioned. It was argued that the scientific quality of sector research was low and that basic research was loosing ground. At this time the economy was booming and resources were made available for increased public research funding, which the Government channelled to the research councils. In the Research Bill of 1987 it was emphasised that sector agencies should increase their long-term research funding. In the Bill of 1990 it was stated that agencies and ministries should strengthen long-term basic research. It was proposed to alter sector agencies towards more research council like organisations with the objective of increasing the influence of scientists in decision processes, i.e. in steering the direction of research.[155]

The new research policy that emerged in the 1980s focused on supporting long-term knowledge development primarily by using the research council model. The importance of the research council model grew at the expense of the sector model. The new research policy also meant that research funding by sector agencies began to change. Long-term knowledge build up within the sectors was emphasised as a responsibility of the agencies/ministries. The scientific community increased its influence in the decision process and scientific quality became the primary criterion when evaluating project proposals. The sector agencies became more like research councils. The new research policy also aimed at achieving an overall planning and coordination of research issues at the level of government. It manifested itself in research bills every third year.

STU - a tool in industrial policy

The link between research policy and industrial policy in the 1970s and 80s was measures taken to make public research useful to society, i.e. steering research towards the technology needs of industry and society. STU, an agency of the Ministry of Industry, had the responsibility for funding technology research of relevance to industry. It was established in 1968 as an instrument for implementing a technology policy by supporting engineering research and development of industrial relevance.[156] In this way STU acted as a mediator between research policy and industrial policy.

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[153] Weinberger H, *Nätverksentreprenören*, Avd. för teknik-och vetenskapshistoria, KTH, 1997
[154] Ibid.
[155] Persson Bo, *Motsträviga myndigheter? Sektorsforskning och politisk styrning under 1980-talet*, Stockholm: SISTER, 2001
[156] STU was one of several new organisations founded for implementing a powerful industrial policy.

During the 1980s increased public research funding was, as mentioned, channelled to research councils. The exception was the funding of the sector agency STU, which got increased research budgets. This was motivated by industrial reasons.[157]

During the 1970s the funding of STU was aimed towards industry's ability to deepen and widen its technological base for new and already existing products and technologies. In the beginning of the 80s STU began to focus more on new research fields and technologies of future relevance to industry. The objective was to renew the scientific and technological base of industry. A central task was to identify and fund research in so-called strategic technologies like ICT, biotechnology and new materials. In the process of identifying research problems in these technology fields, scientists as well as industrialists were involved. STU became a mediator between scientific research and industrial practice and a substitute purchaser of new technology on behalf of a future industry, i.e. STU acted as a change agent in industrial evolution. In a sense research policy and industrial policy converged in the research funding of STU.[158]

When STU in the early 1980s focused its activities on the generation of new technologies like ICT, biotechnology and new materials, the instruments used were the so-called framework programmes and programme areas for special initiatives. These two types of programmes were both of long duration, which made it possible to train doctoral students within these programmes. STU now shifted the focus of funding R&D from products to the generation of knowledge and new technology. An important feature of the STU-programs was that research problems were formulated by STU in close collaboration with scientists at universities and industrial representatives. The programmes were cross-disciplinary. STU also fostered co-operation between industry and universities in the programmes, thus acting as a network entrepreneur.[159]

In Sweden, as in many other OECD-countries, programmes were established in 1980s to promote so-called generic technologies like micro-electronics, biotechnology and new materials. These technologies were judged to be strategic for future technical development and for the competitiveness of national industries. In 1984 a national micro-electronic programme (NMP) was initiated, which included large R&D investments, support for product development and promoting cooperation between universities and industry. Government and industry jointly financed the programme. STU was the most important public agency in the programme since it was in line with the mission of STU. i.e. to increase knowledge and expertise in technology fields of strategic relevance to industry. The generation of the new technology was heavily dependent on investments in basic research, applied research and development activities. Later in the 1980s NMP was followed by the IT4-programme.

The new research policy in the 1980s described above, affected STU. Most important was that STU had to take responsibility for funding basic engineering research in certain fields at universities. STU should fund to long-term knowledge build up in universities.

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[157] Weinberger H, *Nätverksentreprenören*, Avd. för teknik-och vetenskapshistoria, KTH, 1997
[158] Weinberger H, *Nätverksentreprenören*, Avd. för teknik-och vetenskapshistoria, KTH, 1997; Persson Bo, *Motsträviga myndigheter? Sektorsforskning och politisk styrning under 1980-talet*, Stockholm: SISTER, 2001
[159] Ibid.

In 1983 STU set up a scientist-controlled advisory function within the organisation, i.e. a research council function, which should fund basic engineering research. However in the bill of 1990 the Government stated that engineering research needed to be increased and a new engineering research council was proposed. Resources were to be transferred from STU during a three-year period. This meant that STU left the field of basic engineering research.[160]

The principle in the 1980s was that the Government should take responsibility for basic research and industry should take responsibility for technology development. The social democratic Government regarded research policy, especially engineering research, as a supplement to industrial policy. Through increased and focused investments in engineering research the competitiveness of industry would be improved. The role of Government was to guarantee basic engineering research of volume and quality. This included strategic research investments in certain technology fields.[161]

In 1977, a report that concerned the future organisation of the Swedish Board for Technical Development was published.[162] The report strongly underlined the importance of having knowledge of the innovation process and its prerequisites when designing measures supporting technical development. R&D and technical development was seen as one of many elements in innovation processes. However, the innovation perspective presented in the report didn't have any major impact on policy making in the 1970s.

The experiences of STU and the development of innovation theories during the 1980s led the agency to question the linear model of technical progress, i.e. basic research should lead to applied research should lead to development activities. These activities were related to each other but in a much more complicated way, e.g. they could take place at the same point in time. This gave rise to new ideas of how technical progress and innovations come into being. Science was still seen as an engine in innovation, however in a new role. The fact that OECD got interested in innovation theories, cp. the TEP-project, made it politically possible to questioning the linear model.[163]

A new focus in industrial policy – promoting the growth of New Technology Based Firms

During the 1980s main stream industrial policy mainly included facilitating restructuring of industry and improving industrial productivity. Swedish industrial policy was, as in earlier decades, directed towards supporting large well-established companies. However, some measures aiming at supporting new technology-based firms (NTBF) were at hand. For instance STU had ever since its establishment supported inventors in their efforts to start new companies. In the late 1970s the Government's interest in start-ups and the growth in new companies increased. The Swedish Industrial Development Fund was created in 1979 with the objective to encourage profitable growth and innovation in SMEs. Policies to support the funding of research- and

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[160] Ibid.

[161] Persson Bo, *Motsträviga myndigheter? Sektorsforskning och politisk styrning under 1980-talet*, Stockholm: SISTER, 2001

[162] SOU 1997:64, *STUs support for technical research and innovation* (*STUs stöd till teknisk forskning och innovation*)

[163] Weinberger H, *Nätverksentreprenören*, Avd. för teknik-och vetenskapshistoria, KTH, 1997

technology-based start-ups were initiated at the local level, e.g. supporting the establishment of technology parks in the vicinity of universities.[164]

In 1980s the so-called Technopole-program was introduced by STU. The objective was to support commercialization of innovations and technologies developed at universities and technological parks. A number of Technopoles were established in university towns. They provided potential entrepreneurs with financing and support in building companies.

The initial reason for supporting NTBFs was that they were thought to be the big companies of the future. Later this expectation was proved to be 'wrong'. The new NTBFs of the 1980s did not grow to big companies. However they came to play another role in the economy. The NTBFs acted as carriers of new technology in the process of technology diffusion in the economy[165].

The 1990s – innovation a source for economic growth

In the beginning of the 1990s an economic slow down hit Sweden with increasing unemployment and budget deficits. In 1991 the social democrats lost the election for the Parliament and a centre right-wing government came into power. The challenge that met the new Government was to design a policy that turned the slow-down into economic growth. Hence policies that could support increasing international competitiveness of Swedish industry came into focus. In industrial policy the main measures used to counteract the crisis was privatisation of public companies and deregulation of markets.[166]

The new Government identified the emergence of an IT-revolution and of a knowledge society (including increased knowledge content of products and services) as important trends, which had policy implications. The role of the State, according to Government, was to create favourable conditions for the transformation of society. This meant among other things supporting the development of high-tech industries. Policy needed to be concerned with increasing competitiveness of fast-growing high-tech industries. These industries are dependent on a well-functioning infrastructure including a public research system that are able to develop new fields of knowledge and that can collaborate with industry in developing and diffusing new technology. Thus research policy became a policy area of great significance in achieving the objectives of competitiveness and growth.[167]

The growth policy adopted meant that competitiveness should be supported by a well-developed and flexible R&D system. Research should contribute to the renewal of industry. The role of research in economic growth was to act as an engine of renewal. The link between research policy and growth policy was explicit; the task to support long-term competitiveness of Swedish industry based on technology development

[164] Diaco Enrico *et al*, *Teknikparkens roll i det svenska systemet – historien om kommersialisering av forskningsresultat*, *VINNOVA Forum VFI* 2002:3
[165] Ibid
[166] Benner, M., *Kontrovers och Konsensus Vetenskap och politik i svenskt 1990-tal*, SISTER, 2001
[167] Ibid.

became the prime task of research policy. Research and highly qualified researchers was identified as key components in and prerequisites for economic growth.[168]

Swedish research policy incorporated at this time two models for research funding, the research council model (scientifically motivated research) and the sector model (research motivated by societal needs). The new Government decided to introduce a third model for steering the direction of research towards the needs of industry and society, the research foundation model.

An important feature of these new research foundations was that once they had been established Government could not control their activities. These new research foundations became the main instrument for a combined research and industrial policy for economic growth. The centre right-wing Government used the capital of the so-called wage earners funds to establish the foundations. The wage earners funds were liquidated and the capital was transferred to a number of new research foundations. In an economic growth perspective the most important foundations were the Foundation for Strategic Research and the Knowledge Foundation.[169]

The establishment of these foundations meant an inflow of significant resources in the research system. The objective of the foundation's funding was to promote the emergence of new industries and thus future economic growth; their funding of university research should improve the long-term competitiveness of Swedish industry. The objective should be achieved by investments in long-term research and in training of new researchers in strategic technology fields like IT, biotechnology and new materials. The foundations involved both scientists from universities and industrial representatives when deciding scientific agendas.[170]

The choice, according to this Government, of foundations as the instrument for achieving these goals was that foundations compared to research councils and sector agencies were more flexible in relation to the needs of society. Another reason was that future governments could not liquidate them even if they wanted to. The new research-funding model meant that the influence of policy on the direction of research decreased. Large-scale, offensive and multi-disciplinary research investments in strategic technology fields were managed outside the policy domain.[171]

Government invested large sums in enhancing the research system with the objective to establish a platform for new high-tech and science based enterprises. However this policy and investments was one reason for increasing the State's budget deficits. In 1994 the centre right-wing Government lost the election for Parliament and the social-democrats came into power. At this time Sweden had a huge budget deficit. The main challenge of the new Government was to overcome the large budgetary deficits and regain budgetary balance. Thus, the rest of the 90s was characterised by huge reductions in public spending and by cuts in public research funding. These cuts hit faculty bloc grants and research councils (around 15 per cent) and sector agencies. For instance the

[168] Ibid.
[169] Ibid.
[170] Ibid.
[171] Ibid.

budget of NUTEK, the successor of STU, was cut with 300 MSEK (almost a 30% cut). The reduction in the research budget was supposed to be compensated by the research funding of foundations. Cuts in research spending aimed at shrinking funding to the level that existed before the increase.[172]

If the period between 1991 and 1994 mainly was about expanding research, the rest of the 90s was about savings and budget cuts in public research funding. A consequence of the savings was a displacement from public to private research funding. The public research funding by research councils concerned investments in the infrastructure of research, while the private funding by foundations concerned strategic research investments. This was an unintended consequence and a privatisation of research policy. An issue for the Social-Democrats in the second half of the 1990s was to gain control of the research funding of foundations, and to coordinate their funding with other public funding. However, the Government never succeeded in getting full control of the foundations. Coordination of research funding was though, to some extent, achieved through agreements with the foundations.[173]

A changing role of STU

In the beginning of the 1990s a new research council was established; the Research Council for Engineering Research (TFR). In 1983 STU had set up a scientist-controlled advisory function within the organisation, i.e. a research council function. This was an answer to government demands on sectorial agencies of increasing the funding of basic long-term research. This function was separated from STU and formed the basis for the establishment of TFR.[174]

In the closing years of the 1980s ideas were presented of coordinating industrial policy at the agency level. A result was that STU amalgamated with the National Energy Administration and the National Industrial Board into the new agency Swedish Board for Technical and Industrial Development (NUTEK) in 1991. Government emphasised that an important objective of the new agency was to promote collaboration between universities and industry in its research funding activities.[175]

NUTEK used several instruments in its activities to increase collaboration between industry and universities. In the beginning of the 1990s the so-called materials-consortia were introduced together with NFR (SSF was later to take over the responsibility for these consortia). In the middle of the 90s the so-called competence centres were introduced. These aimed at building bridges between science and industry in Sweden by creating excellent academic research environments where industrial companies participate actively and continuously. The programme runs for 10 years. NUTEK's (later VINNOVA) contribution to the cost of the programme is 32%, which means that the other parties - universities and the participating companies - are the main investors.

In hindsight it is possible to identify a line from the framework programmes of STU in the 1980s to materials-consortia and to competence centres. All of them aimed at

[172] Ibid.
[173] Ibid.
[174] Ibid.
[175] Ibid.

steering research towards the demands and needs of industry by involving industry in deciding research problems and in carrying out research. Another objective was to expose academics to industrial problems and vice versa.[176]

NUTEK had, compared to its predecessor STU, lost the funding of engineering research. Later in the 1990s cuts in the budget of NUTEK had impact on its activities. Some activities, e.g. the materials-consortia, were transferred to the research foundations that were established in the middle of the 1990s. NUTEK became more of a networking entrepreneur than a research financier.[177]

Industrial policy emphasise commercialisation of research

The centre right-wing Government in the first years of the 1990s did not only introduce research foundations as an instrument for making research useful to industry and society. It also established organisations with the objective to promote the commercialisation of research. In the Research Bill of 1993 it was proposed that technology parks should be assigned public grants to establish so-called innovation centres, located on university campuses. The reason for the proposal was that universities lacked incentives to commercialise results and collaboration with industry since the intellectual property rights (IPR) of research findings belonged to the researcher, i.e. the so-called ‘teacher exemption’. A new supporting organisation was considered to be necessary.

The proposal resulted in the establishment in 1993 of seven foundations for technology transfer using 1 billion SEK. The objectives of the Foundations for Technology Transfer (Teknikbrostiftelserna) were to promote commercialisation of research findings at universities and collaborations between industry and universities. They came to provide researchers with commercialisation services, e.g. patenting/licensing services and seed financing.[178]

In an effort to bridge the gap between independent inventors and resources for commercialisation of their inventions, the Innovation Centre Foundation (SIC) was established in 1995. As the other foundations established during this period, the capital was originated from the liquidated Employee Monetary Fund. SIC focuses on inventors/inventions in very early stages by offering seed financing.

In the middle of the 1990s the Government also established eleven holding companies, which were expected to support university researchers in developing research findings into patents, which could be licensed out or be the base for spin-offs. Commissioned research for companies should also be handled by these holding companies. In 2001 all universities was given the opportunity to establish holding companies.

In 1995 the Government commissioned a committee (NYFOR) to analyse and propose additional measures, which would improve the societal and industrial use of research. The key issue was to assess whether or not the ‘teacher exemption’ should be abolished

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[176] Ibid.

[177] Weinberger H, *Nätverksentreprenören*, Avd. för teknik-och vetenskapshistoria, KTH, 1997

[178] Diaco, Enrico *et al*, *Teknikparkens roll i det svenska systemet – historien om kommersialisering av forskningsresultat*, *VINNOVA VFI* 2002:3

and the IPR of research findings transferred to universities. The commission recommended keeping the ‘teacher exemption’. It also proposed a new instrument for increasing the commercialisation of research findings. According to the Commission the growth of the knowledge society demanded an increasing collaboration with society and industry. University research and researchers ought to be integrated in technological innovation processes of industry as active partners. The proposal was to give universities the responsibility for making its research useful to society, i.e. a third mission was introduced besides education and research. At that time universities were only obliged to inform about their research. This information duty was regarded to be too passive and having a one-sided view on the role of universities in society.[179]

The point of departure for the Commission was the innovation system perspective. In their argument for the third mission of universities the linear model of innovation was criticized. The role of research in innovations was not only to diffuse research findings to industry. Research also had a role in assisting industrial R&D in its R&D-activities. Thus collaboration was necessary. The universities should be involved as active partners in the innovation process. According to Benner, the NYFOR investigation can be seen as the first attempt to establish an interactive view on the relation between the university and industry.[180] The links between research teams and industrial partners should be strengthened. By introducing the third mission, this could be accomplished.

Government followed these proposals. The ‘teacher exemption’ was preserved and in the Research Bill of 1996 a third mission for the universities was proposed. The third mission, to collaborate with the society, was later included in the Higher Education Act. The Research Bill presented in September 1996 also included guidelines for the research policy. In the Bill it was stated that research should be driven by the needs of society. Research should be made useful through increased collaboration with society and industry. The Bill included several statements indicating a move towards an innovation policy. For instance public research should interface with industrial R&D thus contributing to developing knowledge and technology in industry. The idea was that industrial competitiveness is strengthened by collaboration between industry and universities and that the Government could and should influence collaboration.

Increased policy attention on NTBFs and SMEs

A consequence of the economic crisis in the early 1990s was the questioning of the opinion that the big Swedish multinational companies would generate economic growth also in the future. At this time these companies were struggling, focusing on their core activities and laying-off employees. Thus, future economic growth in Sweden was dependent on the growth of new companies and of existing SMEs. The following initiatives and measures directed towards SMEs were introduced during the second half of the 90s and the first year of 2000.

Invest Forum CapTec is an annual investment forum for young technology-based firms and venture capital companies. The programme began in 1994 and its main objective is funding of young technology-based firms. NUTEK, ALMI and VINNOVA organize the forum.

[179] SOU 1996:70, *Samverkan mellan Högskolan och näringslivet*

[180] Benner, M., Kontrovers och Konsensus Vetenskap och politik i svenskt 1990-tal. SISTER 2001.

In 1994 SNITS (Small and New Companies' Development of Innovations, and Technology Transfer Support) was established with the objective to motivate SMEs to carry out advanced technical R&D projects. The important feature of SNITS is that the small business is required to create an early strategic customer relationship - normally with a large company - during the feasibility study, and initiate discussions with potential investors. The measure consists of financial awards, 200 000 SEK, for feasibility studies including customer contacts and business planning.

The TUFF programme (Technology Transfer for SMEs) was created by NUTEK. TUFF promotes trade in technology services between public R&D technology providers and SMEs. The programme encourages SMEs to cooperate in order to become stronger customers of qualified technology services. It stimulates SMEs' demand through support for feasibility studies and the creation of groups or networks of firms. A technology broker acts as a single entry point to the expertise offered by the entire network. TUFF was the result of a special government mission

In 1996 the Swedish Industrial Fund was mandated to invest in SMEs as a way to support growth. It could invest in equity as a way to strengthen the capital base of SMEs.

In 1997 several Industrial Development Centres were set up to stimulate development processes, competence and products in technology-oriented SMEs and to promote entrepreneurship education in schools.

The Venture Capital Database (Riskkapitaldatabasen) was set up by NUTEK in 1999 to improve access and transparency of the venture capital market. It is a database on the Internet by which start-ups and small firms can search for suitable venture capital companies.

Another measure directed towards new companies was NUTEK's seed financing programme. It was the successor of the STU seed financing.

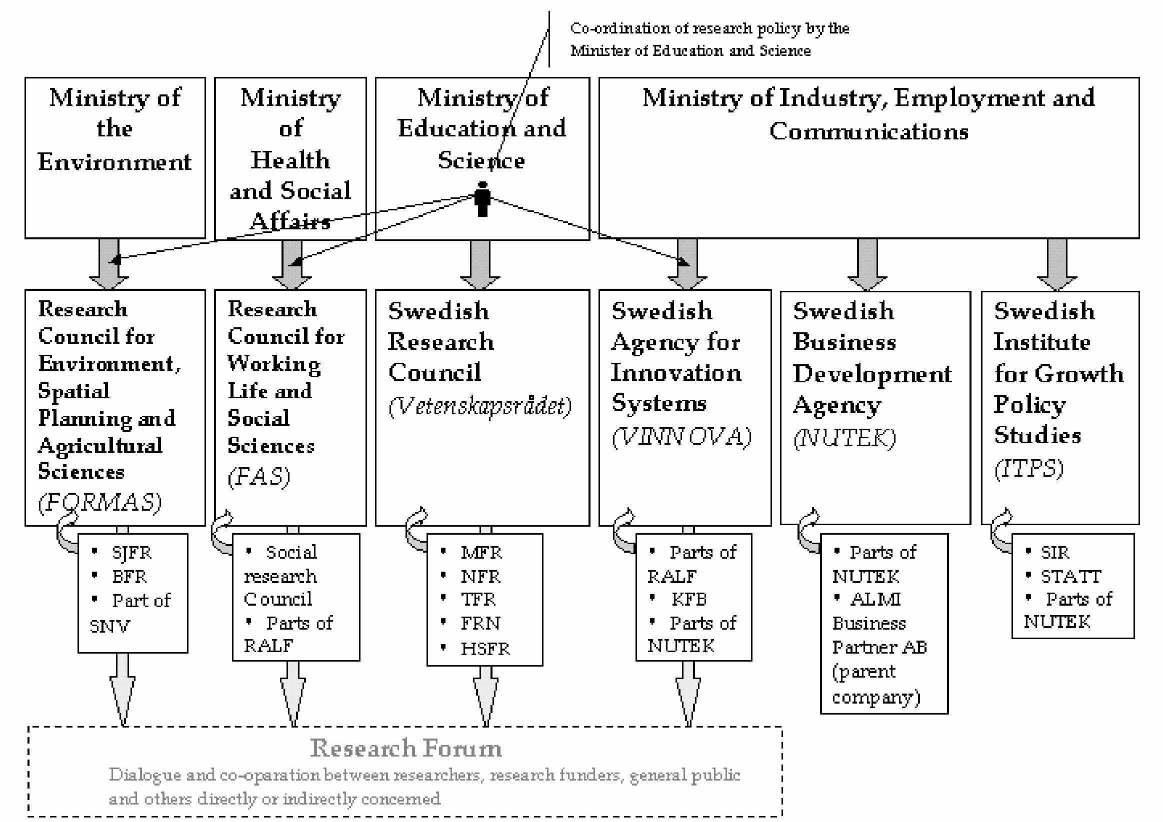
Swedish innovation policy in the first years of the new century

Main themes in the research and industrial policy debate at the beginning of the new century have been the commercialisation of research through supporting interaction and collaboration in the knowledge generating process and fostering spin-offs from research. Research policy and industrial policy have become more and more intertwined being viewed in an innovation system perspective.

A new public research funding structure
In the late 90s a parliamentary commission presented a report labelled Research 2000. It proposed the abolishment of sectorial research funding and the transfer of resources to research councils. This report was important to the reorganisation of the public research funding structure that was presented in two bills in spring 2000. These bills closely relate to each other. The first one, issued by the Ministry of Industry, Employment and Communications, outlines a new organisational structure for public support of business and regional development. The second one, issued by the Ministry of Education and Science, outlines a new organisational structure for public funding of research.

In figure 2 the restructuring is described. The research councils amalgamated into one council, the Science Council. The R&D funding sector agencies was merged into three agencies, FORMAS, FAS and VINNOVA. The first two became more or less research councils while VINNOVA got the character of a sector agency. Its research funding was to be directed towards knowledge fields of industrial importance like information technology, biotechnology and new materials. However this should be done in an innovation system perspective. The objective of establishing VINNOVA was to create an effective and forceful organisation for promoting Swedish innovation systems. It took over the R&D-funding responsibilities from NUTEK, and it also included the activities of the former Transport and Communications Research Board (KFB) and about half of the activities of the former Council for Work Life Research.

Figure 2. The restructuring of the Swedish public RTD funding



The mission of VINNOVA was to initiate and fund need-oriented (primarily the needs of industry) research and development for promoting Swedish innovation systems and sustainable growth. Government argued that the capability of enterprises to innovate is an important factor behind economic growth. An efficient national innovation system was seen as important for economic growth and increasing welfare. The capability to innovate is dependent on several support conditions like education, research, technical development, venture capital, labour market, regulation and legislation, infrastructure of transport and communication.

A Research Forum was established with the mission to coordinate the heterogeneous funding system and to be responsible for research ethics, research in working life, gender and equality, etc.

What was left of NUTEK and ALMI was consolidated into a new NUTEK with the objective to support enterprise development.

The new agencies came into work on January 1st 2001. All in all, the reorganisation involves some 15 organisations. The reorganisation reduced the number of organisations to six. The new structure is to enable more focused public efforts in areas of strategic importance, greater efficiency, and a better adaptation to the needs of target groups.

Rationales for an Innovation policy presented in Government Bills
In the Bill 1998/99:94 'Some research issues' the role of Government within research was treated. It was stated that Government is responsible for guaranteeing the freedom of research (a free choice of research issues, and publication of research findings) and for funding basic research as well as the training of researchers. The need for public funding of basic research and training of researchers is that private capital will not fund such generic and pre-competitive activities due to high risk and uncertainty, i.e. the market failure rationale. The objectives of research policy are the following:

- Sweden should be a prominent research nation, i.e. conduct research of high scientific quality and make research investments that give the opportunity to both breadth and specialisation.
- Research findings should be used by society and/or commercialised by industry.
- Collaboration between society/industry and universities should be improved continuously.

Government stated that research funding must be based in scientific needs and in the needs of different sectors of society. The distribution of funds between these needs is the responsibility of Government. Research at universities must lay the ground (develop new knowledge and train researchers) for R&D in industry, and universities are to have qualified research teams for industry to co-operate with.

In the Bill 1999/2000:71 'Some organisational issues in industrial policy' the theory of national innovation systems is explicitly referred to. It is stated that the wealth of Sweden builds on the ability to innovate. This means, among other things, that Sweden must have a strong base of research. It is also the task of policy to design appropriate framework conditions. Swedish industrial policy and innovation policy needs and perspectives are to be renewed in order to better support industrial needs and to foster innovation abilities and sustainable growth. In the context of innovation systems knowledge generation, collaboration between actors and entrepreneurship are of decisive importance for the generation of innovations.

Future dynamism and innovation abilities in industry will depend on how well the absorption and transfer of knowledge between individuals and enterprises function. Collaboration between university research and industry is a precondition for the exploitation of research findings. It is the responsibility of the State to act as an intermediary and improving the exchange.

An innovation system includes those conditions and actors, which together contribute to the generation, use and diffusion of knowledge in order to develop products and services. The national innovation system includes many different sub-systems (regional and sectoral) with their own dynamic and driving forces. Research and education are important parts in these systems as well as entrepreneurship, venture capital, rules like taxes and standards. The functioning and dynamism of systems is also dependent on how well actors interact and exchange knowledge.

In the Bill 2001/02:2 'R&D and collaboration in the innovation system' principles are presented concerning need-oriented research in the context of the national innovation system as well as measures to strengthen the innovation system. Government argues that society is becoming more and more dependent on knowledge and the ability to apply this knowledge to industrial and societal problems. R&D and innovations are fundamental driving forces in economic growth and increased welfare. This means that issues concerning education, R&D and innovations are in the focus of welfare- and growth- policy. Industry often needs access to first-rate expertise/competence, research environments and new research findings to be able to develop new products and services and thereby to increase its competitiveness. The importance of need-oriented research to competitiveness and economic growth has increased due to the growing importance of innovation. Need-oriented research in universities contributes to innovation in industry and the public sector. At the same time need-oriented research identifies new research issues for basic research. This exchange and loops of collaboration contribute to mutual learning in universities and industry.

According to the Government the efficiency of a national innovation system is highly dependent on well-functioning collaboration between enterprises, research institutes, universities and financiers of need-oriented research. It is important to transform knowledge into innovations and an important task of Government is to promote entrepreneurship and to create conditions that foster new enterprises and growth of enterprises.

The Government states in the Bill that innovation policy is of great importance for economic growth. Enterprises in expansive and knowledge intensive industries often localise sites in countries with efficient innovation systems, high quality research and a well-educated labour force. Hence, Sweden must be competitive in these fields. Innovation policy must build on clearly defined responsibilities of the State and other actors. The responsibility of the State is to create conditions that promote economic growth in all parts of the country. Innovation policy aims at designing good conditions for innovative activities, e.g. supplying an excellent infrastructure as regards education and research

The State has the responsibility to create conditions that foster innovation. It also has a responsibility to fund need-oriented research in areas of commercial potential. Objectives of need-oriented research are:

- high scientific quality and industrial relevance
- research in fields of technologies with future economic growth potentials
- public-private co-financed R&D
- promote international R&D collaboration
- promote commercialisation of research findings

- facilitate knowledge exchange and mobility between universities and enterprises

Regional Policy and Innovations
A regional policy bill 'A Policy for Growth and viability throughout Sweden' presented in 2001/02:4, focused on the establishment of a new policy field - regional development policy. The purpose was to establish a well-coordinated policy for all parts of the country, i.e. to create regions with well-functioning and sustainable local labour markets and with good services. Furthermore, municipal co-operation bodies should be established in all counties from the year 2003. These partnership bodies will have the authority to make decisions about county plans for regional infrastructure and authority to decide about some governmental funds for regional development. This was a major change in regional policy. One task of these bodies is to create programs for the development of the county, e.g. regional growth programs. The present regional growth agreements will develop into regional growth programs in 2004.
The programme 'Regional growth through dynamic innovation systems' (VINNVÄXT) was introduced by VINNOVA in 2002. The aim is increased growth and innovation activities in selected functional regions through increased co-operation between universities, companies and public organisations. The concept of the programme is the promotion of effective local cooperation between companies, research and development organisations and the political system (the triple helix) within each region, with the aim of achieving dynamic regional innovation systems that will allow the region to be competitive at an international level within specific areas of growth. VINNOVA is allocating € 4,5 million per year to selected regions (5-10) after a competitive call for proposals, and will offer support for process management and competence development in that specific area.

Recent developments
In the spring of 2002 the Government initiated a process that aims at creating a new policy field, i.e. the field of innovation policy. This calls for integrating parts of industrial policy and of research policy. It also demands an integration of departments within the Ministries of Education and of Industry, Employment and Communication as well as integration between the two ministries.

Innovation policies have for some years been an important part of the debate that has focused on the seeming Swedish paradox of slow long-term economic growth and simultaneously very high R&D-spending, primarily by industry. As a consequence the efficiency of the national innovation system (although not always discussed in this wording) in terms of producing innovation and economic growth has been questioned. One aspect of the debate concerns the commercialisation of university research and how to increase it. In this debate it has been proposed to alter intellectual property rights and tax regulations, to increase public seed funding and the number of incubators. Arguments have also been voiced for the necessity to improve national, regional and sectoral innovation systems in order to increase economic growth. During the summer of 2002 the Prime Minister and the Minister of Education and Science and the Minister of Industry, Employment and Communications argued in media for improved innovation systems as one way to increase economic growth.

As a response to Sweden's apparent 'paradox' the Minister of Industry and the Minister of Education jointly established a process for better-coordinated policy responses. The

Innovation Policy Expert Group (IPE) was established to assess the systemic factors to be addressed.[181] As one result of the work, ITPS was mandated to measure the barriers to entrepreneurship in the Swedish economy. The Government is also considering adjustments in taxation.

Within the process a series of reports have been produced. The first report, commissioned by the Ministry of Industry, Employment and Communication and Ministry of Education and Science, aims to be a starting point for the work and a process that will lead to a gathering around the issue of innovation and competitiveness.

Another report concerning the subject was published in May 2002 by the so-called Bennet & Jonsson Group, 'The future of Swedish Industry'. The group consisted of representatives from industry (primarily large multinational enterprises) and labour unions. The group proposed measures in 15 fields that would support the competitiveness of Swedish industry and increase economic growth. One field concerned the issue of how to improve the Swedish innovation system and others concerned the need for collaborative research between universities and industry in different technologies. The Minister of Industry, Employment and Communication commented on the report in a press release. He agreed with many of the proposed measures and said that it was his ambition to improve the conditions for innovativeness.

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[181] The final report by IPE has been published, see Andersson T, et al.Betydelsen av Innovationssystem, utmaningar för samhället och för politiken. VINNOVA, VFI 2002:1

Government Bill 1999/2000:81 *Research for the Future – A New Organisation for Financing Research*.

Government Bill 2001/02:2 *R&D and collaboration in the innovation system*

Government Bill 2001/02:4 *A Policy for Growth and Viability throughout Sweden*

SOU 1996:70 *Samverkan mellan Högskolan och Näringslivet.*

SOU 1977:64 *STU's support to technical development and innovation*

Statistical annex

In this appendix is presented numerical data for the figures presented in the chapter on Nordic Innovation Indicators.

Structural indicators

Table A.1.1: Educational attainment of the population, 2001

	ISCED 1 -2		ISCED 3-4		ISCED 5-6	
Country	**pre-primary and primary education**	**lower secondary education**	**upper secondary education**	**post secondary non-tertiary education**	**tertiary-type B education**	**tertiary type A and advanced research programmes**
Denmark		20	52	2	19	8
Finland		26	42		17	15
Iceland	2	34	29	10	6	19
Norway	1	14	54	3	3	26
Sweden	9	10	49		15	17
OECD		19	41	3	8	15

Source: OECD Indicators 2002, Education at a Glance

Table A.1.2: Gross Domestic Product, GDP, in million current PPP$

Country	1991	1996	1997	1998	1999	2000	2001
Denmark	93 408	127 390	135 022	141 543	147 208	155 126	160 047
Finland	79 279	99 538	108 708	114 010	120 925	130 307	134 160
Iceland	4 657	6 305	6 760	7 244	7 676	8 243	8 546
Norway	79 541	111 541	121 576	125 658	129 509	135 474	140 282
Sweden	150 449	181 479	192 566	195 136	207 960	220 384	228 180

Source: OECD 2002/1: Main Science and Technology Indicators

Table A.1.3: Total tax revenue as percentage of GDP, 1999

	Denmark	Finland	Iceland	Norway	Sweden	OECD
Tax revenue	50,6	46,5	35,4	41,8	52,1	37

Source: OECD 2002: Trends in Tax Burdens and Tax Structures

Resources to research and development

Table A.2.1: Gross Domestic Expenditure on R&D (GERD)

Country	GERD in million current PPP$ 1999	GERD in million current PPP$ 2000	GERD as a percentage of GDP 1999	GERD as a percentage of GDP 2001 [2)]	GERD per capita population in current PPP$ 1999	GERD per capita population in current PPP$ 2001	GERD per capita in Norwegian crown, 2001[2)]
Denmark	3071		2,09	2,43	577		6518
Finland	3893	4460	3,22	3,40	754	861,6	8274
Iceland	179	215	2,33	3,01	645	765,9	8164
Norway	2198	2432[1)]	1,70	1,62	493	538,9[1)]	5416
Sweden	7865		3,78	4,28	888		10208
OECD	557157	602899	2,21		501		

Source: OECD 2002/1: Main Science and Technology Indicators
1)2001 2) Source: NIFU 2003

Table A.2.2: Percentage of GERD per source of finance, 1999

Country	Industry	Government	Other national sources	Abroad
Denmark	58	33	4	5
Finland	67	29	1	3
Iceland	43	41	2	14
Norway	50	43	2	6
Sweden	68	25	4	4
OECD	63	30	5	

Source: OECD 2002/1: Main Science and Technology Indicators

Table A.2.3: Percentage of GERD performed by sector, 1999[1)] and 2001[2)]

Country	Business Enterprise Sector 1999	Business Enterprise Sector 2001[2)]	Higher Education Sector 1999	Higher Education Sector 2001[2)]	Government Sector 1999	Government Sector 2001[2)]	Private Non-profit Sector 1999
Denmark	63	69	20	22	15	9	1
Finland	68	71	20	18	11	11	1
Iceland	47	59	21	19	30	23	2
Norway	56	60	29	26	15	15	
Sweden	75	78	21	19	3	3	
OECD	69		17		11		3

1) OECD 2002/1: Main Science and Technology Indicators 2) NIFU

Table A.2.4: Researchers and R&D personnel in total FTE and per thousand total employment, 1999

	Denmark	Finland	Iceland	Norway	Sweden	OECD
Total ***researchers*** (FTE)	18 438	25398	1578	18295	39921	3248999
Total researchers per thousand total employment	6	10	10	8	9	6
Total ***R&D personnel*** (FTE)	35 650	50604	2390	25400	66674	
Total R&D personnel per thousand total employment	12	20	15	11	15	

Source: OECD 2001/2: Main Science and Technology Indicators

Table A.2.5: Business Enterprise, Higher Education and Government researchers 1999[182]

	Business Enterprise researchers (FTE)	Business Enterprise researchers as a percentage of national total	Business researchers per thousand employment in industry	Higher education researchers (FTE)	Higher Education researchers as a percentage of national total	Government researchers (FTE)	Government researchers as a percentage of national total
Denmark	8575	47	5	5722	31	3918	21
Finland	10555	42	7	10395	41	4115	16
Iceland	626	40		480	30	422	27
Norway	9737	53	7	5521	30	3037	17
Sweden	22822	57	9	14623	36	2423	6

Source: OECD 2002/1: Main Science and Technology Indicators

Table A.2.6: Higher Education Expenditure on R & D HERD, 1999

	HERD on R&D in million current PPP$	HERD as a percentage of GDP
Denmark	623	0,42
Finland	768	0,63
Iceland	37	0,49
Norway	629	0,49
Sweden	1683	0,81
OECD	96223	0,38

Source: OECD 2002/1: Main Science and Technology Indicators

Table A.2.7: Government Budget Appropriations or Outlays for R&D, GBAORD in percentage of GDP, 1999

Country	1999
Denmark	2,1
Finland	3,2
Iceland	2,3
Norway	1,7
Sweden	3,8

Source: Nordic Statistical Yearbook 2002

[182] Data is not available for business enterprise researchers per thousand employed in industry in Iceland.

Innovation in industry

Table A.3.1: Business Enterprise Expenditure on R&D, BERD 1999

Country	BERD in million current PPP$	BERD as a percentage of GDP	BERD as a percentage of value added in industry
Denmark	1947	1,32	2,14
Finland	2654	2,19	3,26
Iceland	83	1,09	1,33
Norway	1230	0,95	1,45
Sweden	5908	2,84	4,35
OECD	385365	1,53	

Source: OECD 2002/1: Main Science and Technology Indicators

Table A.3.2: Percentage of BERD per source of finance, 1999[183]

Country	Industry	Government	Other national sources	Abroad
Denmark	89	4	1	6
Finland	94	4	0	1
Iceland	77	2	0	21
Norway	83	10	0	7
Sweden	89	8	0	3
OECD	88	9	0	

Source: OECD 2002/1: Main Science and Technology Indicators

Table A.3.3: Total business R&D broken down by size classes of firms in 1999 percentages; total in millions of PPP dollars[184]

Employees	Denmark	Finland	Iceland	Norway	Sweden
Fewer than 500	39	29	95	55	18
500 or more	61	71	5	45	82
Fewer than 100	16	14	39	26	4
100 to 499	23	15	57	29	14
500 to 999	13	10	3	45	10
1000 or more	47	61	2		73

Source: OECD 2001: Science, Technology and Industry Scoreboard

[183] Data for OECD is secretariat estimate or projection based on national sources and percentage of BERD financed abroad is missing.
[184] To compare the countries by size classes the data had to be aggregated according to two categories: fewer than 500 and 500 or more employees, as countries had not broken data into identical classes.

Patent data and Bibliometric Indicators

Table A.4.1: Number of patents in the ICT sector, applications to the EPO (priority year), 1997

Denmark	43
Finland	378
Iceland	3
Norway	46
Sweden	375

Source: OECD 2001/2: Main Science and Technology Indicators

Table A.4.2: Number of patents in the biotechnology sector, applications to the EPO (priority year)

Denmark	52
Finland	12
Iceland	0
Norway	9
Sweden	35

Source: OECD 2001/2: Main Science and Technology Indicators

Table A.4.3 Scientific papers as a share of the scientific production in the world, 1981-2000

	Denmark	Finland	Norway	Sweden
1981	0,84	0,57	0,50	1,50
82	0,84	0,62	0,53	1,60
83	0,82	0,65	0,53	1,60
84	0,80	0,66	0,51	1,65
85	0,79	0,62	0,53	1,67
86	0,82	0,63	0,50	1,66
87	0,80	0,66	0,50	1,64
88	0,76	0,62	0,49	1,63
89	0,78	0,63	0,47	1,66
90	0,77	0,65	0,50	1,64
91	0,77	0,66	0,49	1,60
92	0,82	0,67	0,52	1,58
93	0,81	0,71	0,52	1,65
94	0,85	0,74	0,52	1,65
95	0,83	0,74	0,55	1,65
96	0,83	0,77	0,54	1,71
97	0,84	0,79	0,55	1,70
98	0,88	0,78	0,56	1,71
99	0,86	0,80	0,55	1,70
2000	0,87	0,82	0,54	1,66

Source: Norges Forsningsråd 2001

Table A. 4.4 Scientific papers per thousand inhabitants, 1981-85 and 1996-2000[185]

	1981–1985	1996–2000
Denmark	3,8	6,7
Finland	3,1	6,4
Iceland	1,4	5,1
Norway	3,0	5,2
Sweden	4,6	8,0

Source: Norges Forskningsråd 2001

[185] See table A.4.4