Innovation and Innovation Policy in the Nordic Region

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Abstract

This paper reports on a desk-study on innovation performance and policies influencing it in four Nordic countries. The study is entirely based on published sources, either on the web (Eurostat, the OECD, the World Bank etc.), or in the form of articles, books, reports and evaluations. The first section introduces the study and deals with conceptual issues. Section two contains a descriptive analysis of innovation activities in the Nordic area and a broader set of countries with which the Nordic countries may be compared with the help of data from the Community Innovation Survey (CIS) and other relevant sources. Section three of the paper, then, presents - for four Nordic countries – an analysis of their innovation policies and how these have evolved towards their present stance. Lessons and questions for further research are discussed in the fourth and final section.
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1. Introduction

This paper reports on a desk-study on innovation performance and policies influencing it in four Nordic countries. The study is entirely based on published sources, either on the web (Eurostat, the OECD, the World Bank etc.), or in the form of articles, books, reports and evaluations.[1]

Why is innovation and associated policy instruments interesting for a study of the Nordic countries' development? The reason, we will argue, is mainly the close relationship that economic theory postulates between innovation broadly defined and economic growth. The notion "broadly defined" signals that the term innovation in the present context encompasses the entire innovation process from, say, the creation new products, processes or ways to do things to the application and spread of these in the economic system. It would of course be possible to define innovation more narrowly, and for some purposes that may be justifiable or even essential. However, with respect to the effects on the economy, a broad perspective is the most appropriate, since what matters economically is not mainly the occurrence of new innovations but their subsequent diffusion in the economic system and the learning effects, further improvements and changes that this gives rise to.[2]

The increasing focus on innovation among economists and social scientists from the 1970s onwards gave around 1990 birth to a new and more holistic way to analyze innovation dynamics at the national level, the national systems of innovation approach (Freeman 1987, Lundvall 1992, Nelson 1993), which subsequently have been applied in studies of a number of different countries (see e.g., Edquist and Hommen 2009). The approach has also been adopted by the OECD in its evaluations of the national innovation systems and policies affecting them in for example Norway and Sweden (OECD 2008, 2013). One of the characteristics of the approach is a strong emphasis on having a historical perspective. A national system of innovation, it is argued, is formed over a long period of time through interaction – or coevolution - between its economic system (major industries, firms etc.) and its political system (Fagerberg et al. 2009a,b). Such processes, though which one part of the system influences the other and vice versa, are also likely to be path dependent, meaning that established policies – and the organizations carrying them out – may be remarkably persistent in spite of changes in the environment. As argued by Narula (2002) this may lead to a situation in which established actors in areas of traditional strength may find themselves much better served by the system than new actors in emerging sectors.

The term "innovation policy" is relatively new and may be used in different ways. However, the fact that the term itself is quite recent does not imply that policies affecting innovation did not exist before. On the contrary, innovation is an old phenomenon and so are policies affecting it. Therefore, when discussing the evolution of the national innovation systems and innovation policies in the Nordic countries, we try to include, when relevant, policies or parts thereof with other labels, such as science policy, research policy, technology policy, industrial policy etc. A broad definition of innovation policy might be the set of policy instruments that affects the innovation performance of a country, while a

[1] It would of course have been interesting to collect new data on the subject through surveys or interviews etc. but given the limited time and resources this was not possible.

[2] An early advocate of a broad perspective on innovation was Christopher Freeman, one of the most influential pioneers in the field of innovation studies. See Fagerberg et al (2011) for more on Freeman's work.

narrower definition might include only policy instruments explicitly created with the effects on innovation in mind. A clear advantage of the broad definition is that it encourages the analyst to consider the possible impact on innovation of policy instruments created with other purposes in mind, such as, for example, health policy, which arguably has played a very important role for innovation in the United States just to mention one example. However, although we find the broad definition of innovation policy preferable from a theoretical point of view, and we will attempt to apply it, the present study cannot – given its limitations – go further in this respect than the sources, e.g., the existing literature on the subject, allows.

The next section contains a descriptive analysis of innovation activities in the Nordic area and a broader set of countries with which the Nordic countries are compared with the help of data from the Community Innovation Survey (CIS) and other relevant sources. The analysis shows that although the Nordic countries have much in common there are also important differences between the innovation activities of these countries. Section three of the paper, then, presents - for four Nordic countries – an analysis of their innovation policies and how these have evolved towards their present stance. Finally, section 4 considers some of the lessons from the study.

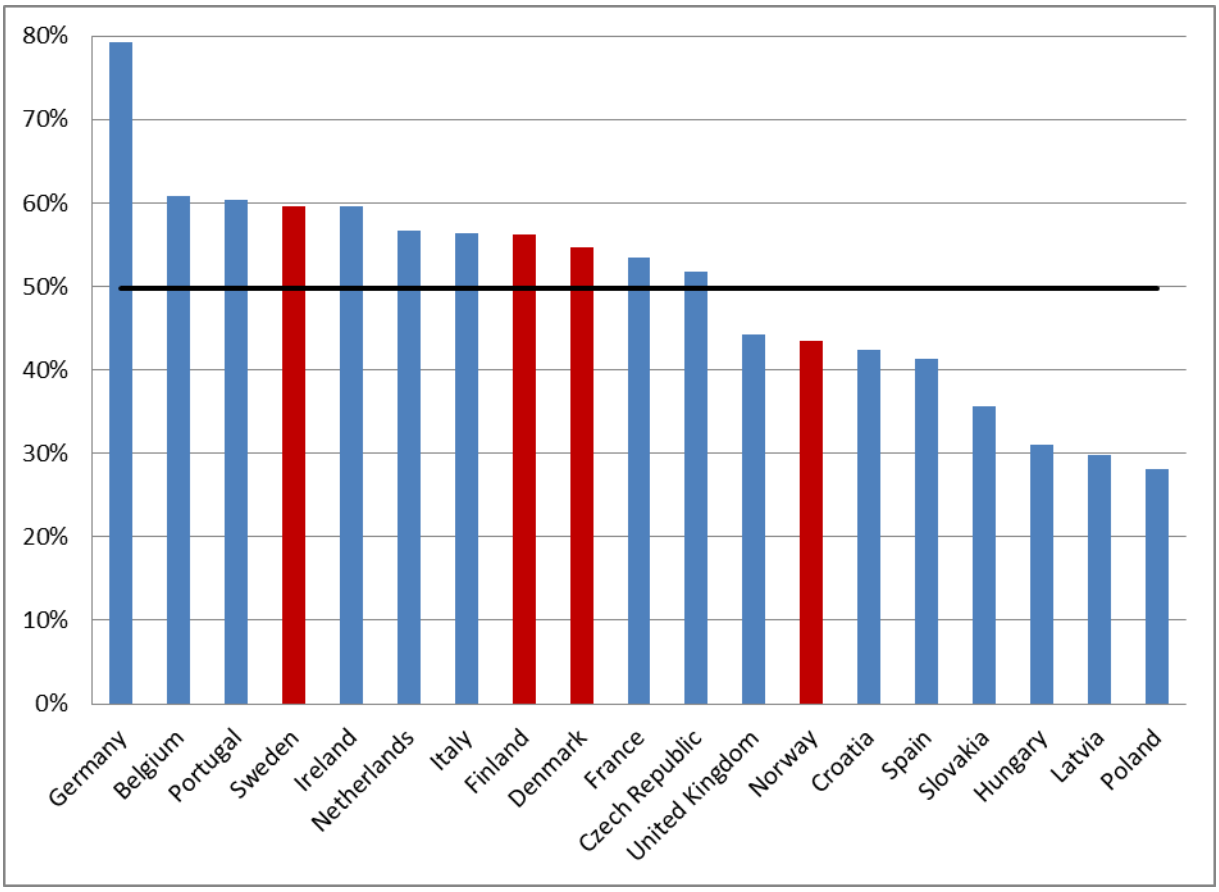
2. Innovation-activities in the Nordic region

This section presents a descriptive analysis of the innovation activities of the four Nordic countries included in the study and a wider set of European countries with which the Nordic countries are compared. The main questions will be: How innovative are the Nordic countries compared to the rest of Europe? What are the characteristics of the innovation systems in the Nordic area, for example with respect to capabilities and resources for innovation, compared to systems elsewhere? To what extent do the firms in the various countries consider their national innovation systems to be supportive? The main source of information on innovation will be the Community Innovation Survey (CIS) which is based on information from many thousands firms all over Europe. This information is supplemented by statics from other sources, e.g., OECD and the World Bank, on various capabilities and resources of relevance for innovation.

Figures 1-2 present statistics on the extent to which a country's firms engage in innovation. Although the questionnaire contains a relatively elaborate definition of innovation (with examples) to assist firms in their assessments it has to be kept in mind that the answers reflect the firms' subjective perceptions.[3]

[3] The responses may also be influenced by other factors, such as differences in culture and language, whether participation in the surveys is mandatory or voluntary, size and definition of the surveyed population, how the survey is conducted etc. (see e.g., Wilhelmsen 2014).

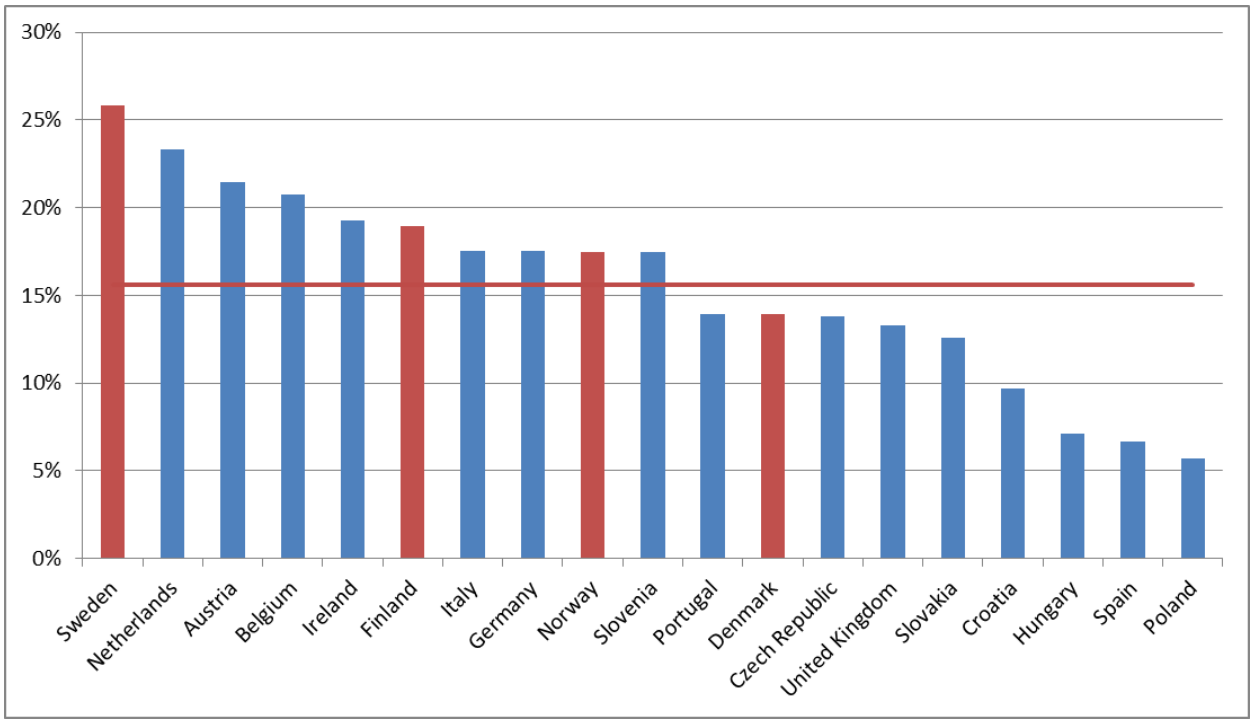
Figure 1. Innovative Firms, 2010
(broadly defined, share of all firms)



Source: Authors' calculations based on Eurostat (CIS 7)

Figure 1 reports the answer to the question of whether or not the firm has undertaken an innovation (independent of type) that was "new to the firm" during the year covered by the survey. This very broad definition of innovation evidently includes "innovations" in use elsewhere but not by the firm in question, i.e., activities that in other contexts might have been categorized as "imitation" or "diffusion". However, such activities are of course economically very important, so their inclusion here might be seen as highly relevant. The results suggest than on average about half of Europe's firms are innovative in this broad sense of the term, with Germany in a clear lead followed by Belgium. Three of the Nordic countries, Sweden, Finland and Denmark (in that order), have levels of innovation activity above the European average. The Norwegian level, in contrast, is below average.

Figure 2. Radical innovators, 2010
(share of all firms)



Source: Authors' calculations based on statistics from Eurostat (CIS 7) on product innovations that are "new to the market"

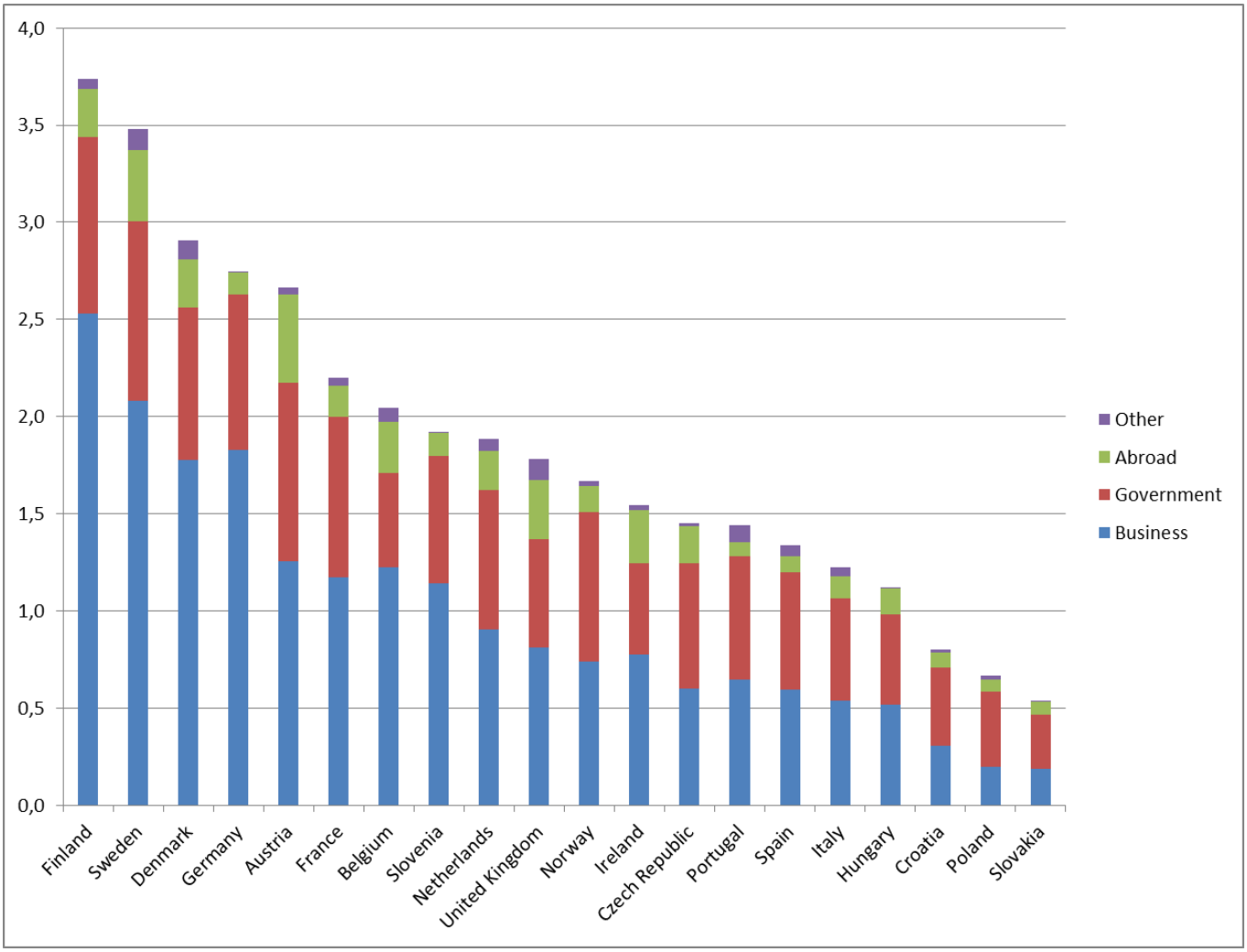
Figure 2 reflects the answers in the CIS survey about the extent to which a country's firms have engaged in product innovations that are new not just to the firm itself but also "to the market". Such innovation is clearly more demanding and, arguably, also more comparable across countries.[4] The first thing to note is that the average propensity to innovate drops from 50% to 15% when this (narrower) definition of innovation is adopted. The dispersion around the mean also increases. Sweden and Finland, which did well according to the broad definition, continue to excel. However, compared with the previous graph the positions of Denmark and Norway are reversed (with Norway above and Denmark below the European average).

[4] What is "new to the firm" has a lot to do with how advanced the firm - and the environment in which it operates - are. So what is "new" to, say, a Polish firm in a particular industry may not be new to a similar firm in Sweden. This complicates cross-country comparisons. Markets, on the other hand, are external contexts that firms, often with different national origins, share. Therefore, the frequency of "new to the market" innovation may be easier to interpret and compare across different national contexts than similar statistics on "new to the firm" innovation.

Another indicator which is commonly used in analyses of innovation at the national level is R&D as a share of GDP (Figure 3). R&D and innovation is not the same, i.e., not all R&D has innovation as its purpose, and not all innovation requires R&D. Still there is a close connection, since R&D – directly and indirectly – plays an important role in many innovation processes.

Figure 3. R&D as a share of GDP, average 2007-2011

(total and by funding sector)



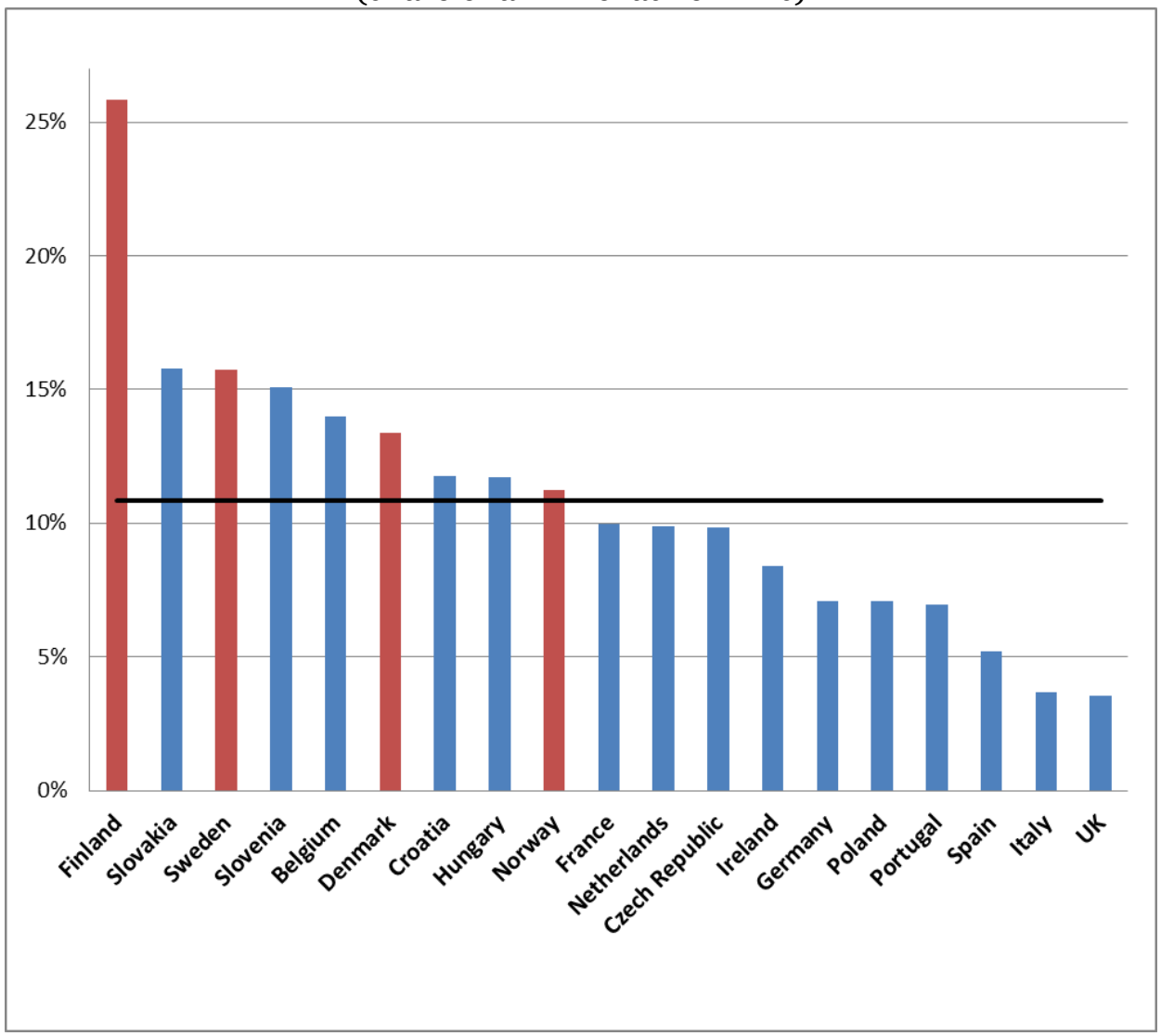
Source: Authors' calculations based on Eurostat

Finland and Sweden are not only among the top innovation performers but also on the top when it comes to R&D investments. The Danish R&D level is also high while Norway's level is considerably behind those of the other Nordic countries.[5] Note also that the major reason why countries differ in R&D as a percentage of GDP is not differences in publicly financed R&D but differences in what the firms in the various countries spend for this purpose.

However, innovation is not only about what happens inside firms but also about their ability to interact with other actors in the innovation system, being customers, suppliers, R&D institutions and so on. Figure 4 measures the extent of such cooperation in various European countries as reported by the CIS. The results indicate that Finland trumps all other European countries in this respect by a wide margin. Sweden and Denmark also perform relatively well, while Norway's performance is closer to the European average.

[5] It has been shown that if one adjusts for differences in specialization patterns, the gap between Norway's R&D intensity and that of other countries at a similar level of development becomes smaller or disappears altogether. Thus Norway's low R&D intensity has much to do with the country's pattern of specialization. However, Fagerberg et al (2009 a,b) have shown that this finding does not carry over to innovation: Differences in specialization patterns explain very little of the gap in innovation performance, as reported by the CIS, between Norway and the other Nordic countries.

Figure 4. Innovation Cooperation, 2010
(share of all innovative firms)

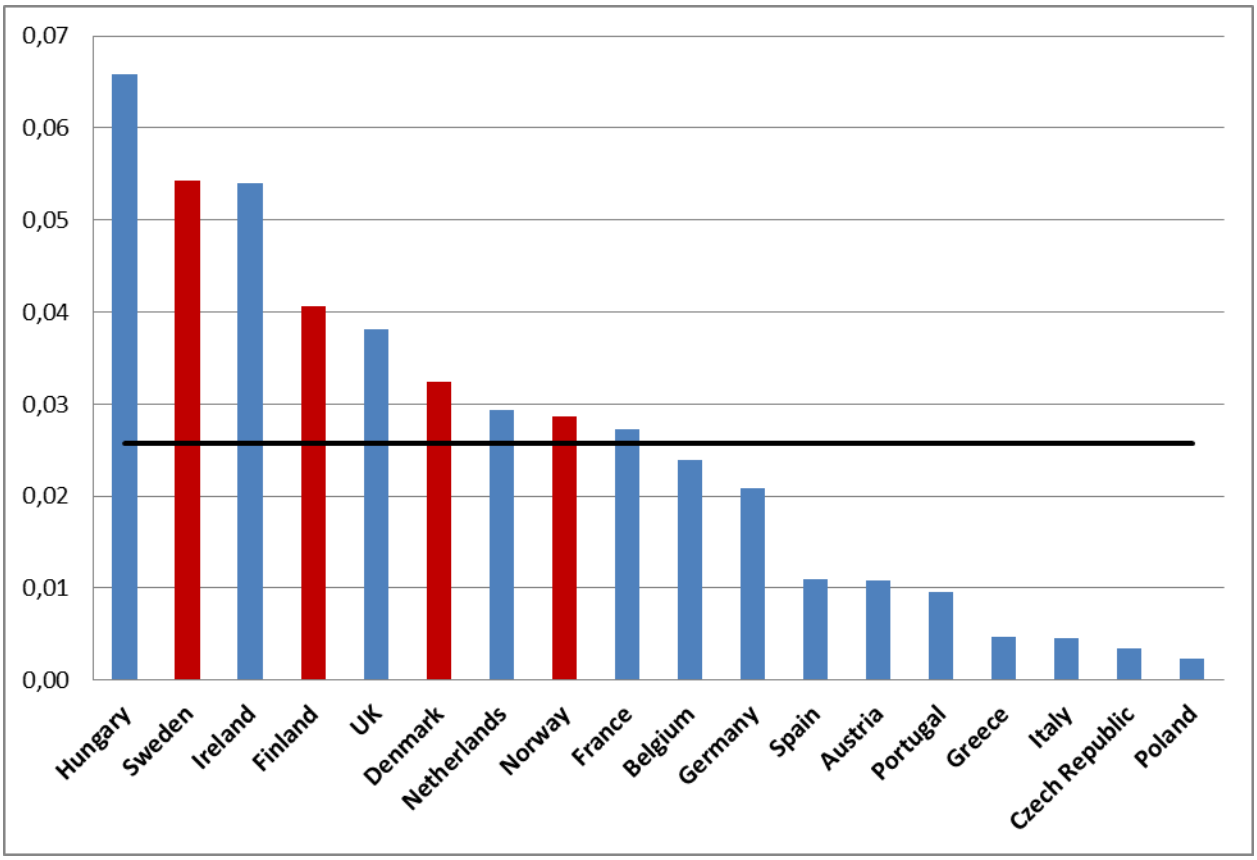


Source: Average propensity to cooperate with external partners in innovation projects. Authors' calculations based on Eurostat (CIS 7)

Having considered innovation performance, the role played by R&D and the degree of interaction between the actors in the system, we now shift the focus to some of the other societal factors that influence innovation at the national level such as the supply of finance for innovation, the skills of the labor force and the attitudes of population with respect to new technology. As for finance, as reflected

by the supply of venture capital,[6] the picture is the by now a familiar one with Sweden and Finland close to the top, and Denmark and Norway closer to the European average.

Figure 5. Venture Capital, per cent of GDP, 2012



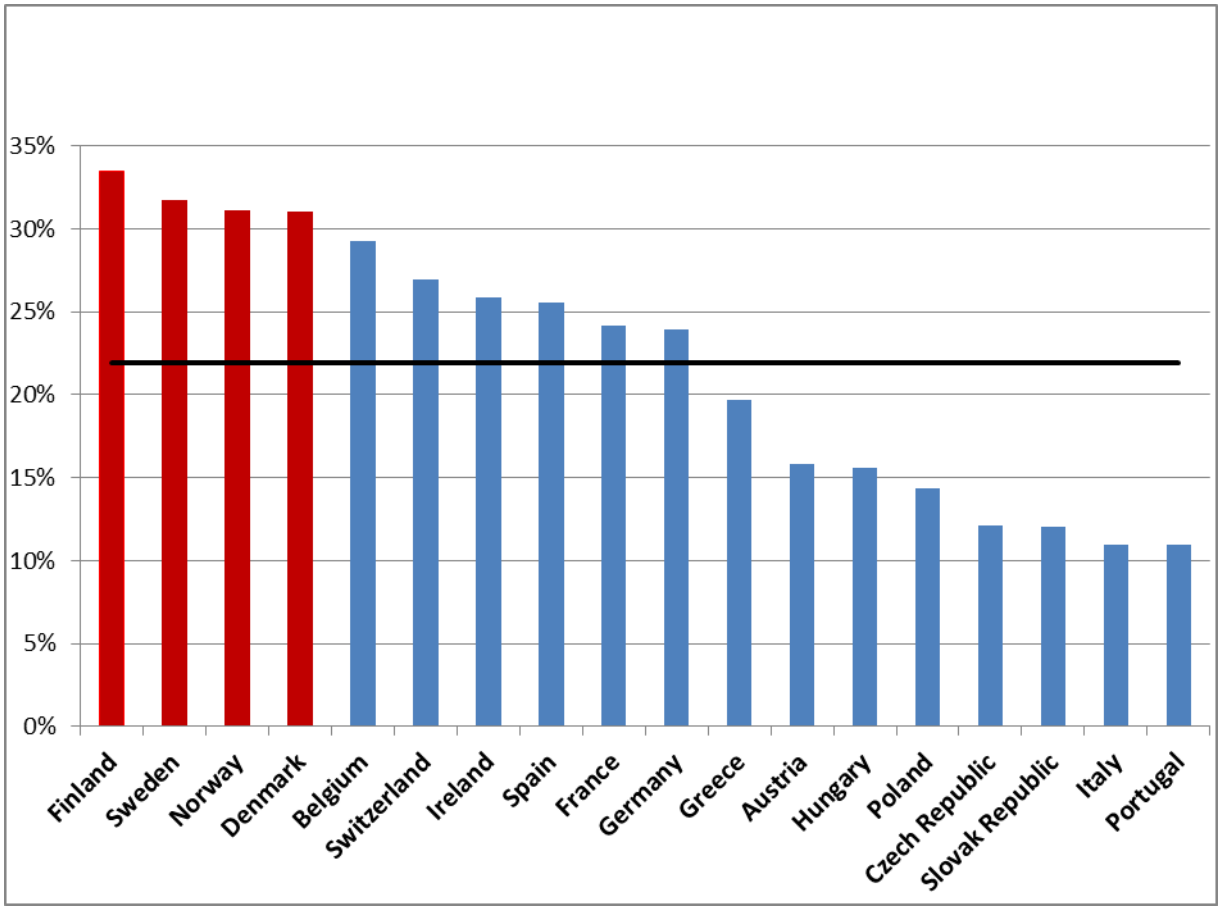
Source: Authors' calculations based on statistics from the OECD

However, when it comes to skills, as reflected in the share of the labour force with tertiary education (Figure 6), all Nordic countries excel compared to the rest of Europe, and the same holds to a large extent for internet activity (Figure 7), used here as an indicator of the attitudes of the population to the adoption of new technologies.

[6] The OECD defines "Venture capital" as follows: Venture capital is a subset of private equity (i.e. equity capital provided to enterprises not quoted on a stock market) and refers to equity investments made to support the pre-launch, launch and early stage development phases of a business.

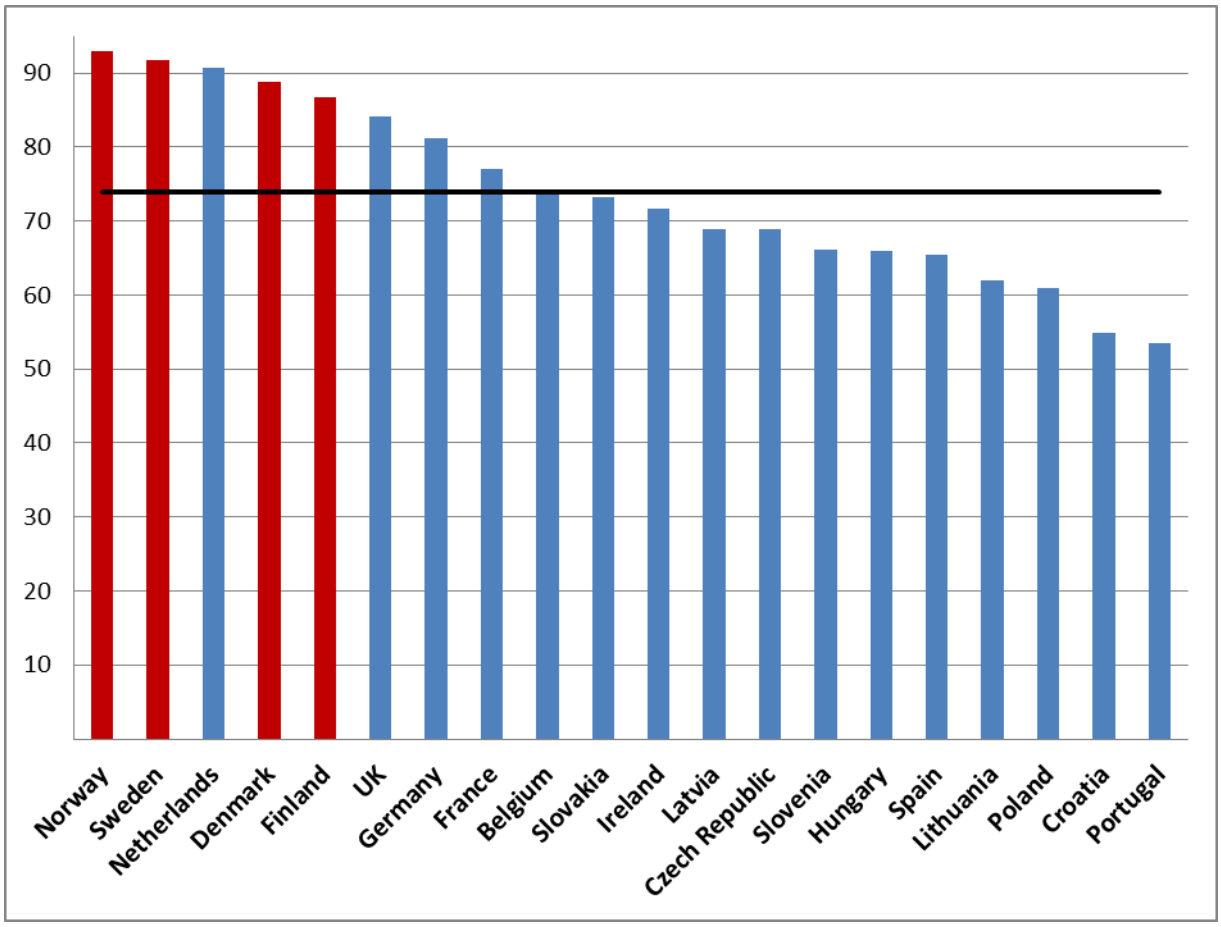
Figure 6. Tertiary education, average 2000-2006

(Share of population age 25-64)



Source: Authors' calculations based on statistics from the OECD.

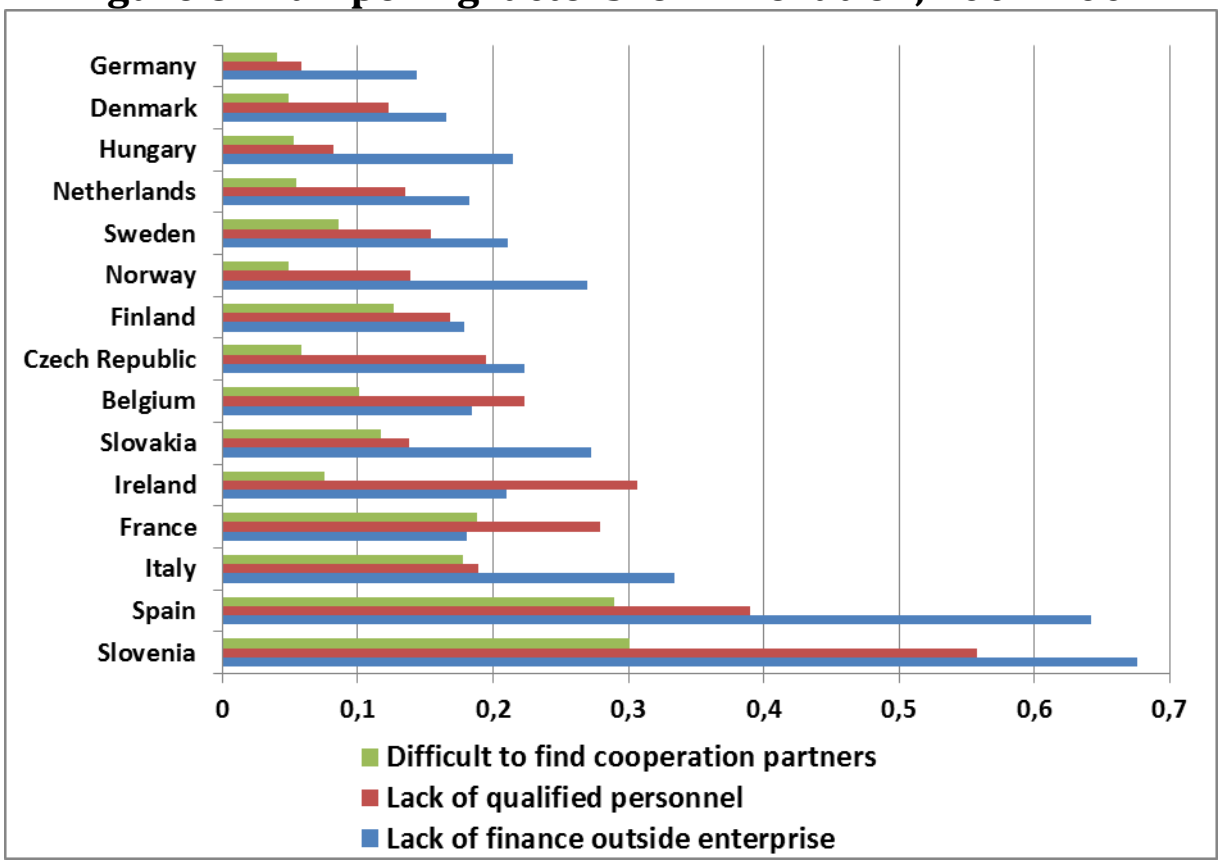
Figure 7. Internet users, per cent, average 2008-2012



Source: Authors' calculations based on statistics from the World Bank

Figure 8 is concerned with some of the same issues but from a different perspective, that of the firms themselves (as revealed by the CIS). The question in this case is what the firms regard as being the most important hampering factors for innovation. Unfortunately these data are a bit dated, as not all questions are included in all surveys and the number of countries participating in the different waves of the survey also differs somewhat. For what they are worth, however, the results indicate the national innovation systems in the Nordic countries are among the most conducive in Europe with respect to innovation in firms. Note also that the results confirm the finding from Figure 5 that access to finance appears to be a constraining factor for innovation in the Norwegian case.

Figure 8. Hampering factors for innovation, 2002-2004



Source: Authors' calculations based on Eurostat (CIS 4). Normalized by share of innovative firms in firm population.

Summing up, the national innovation systems in the Nordic area are among the most advanced, if not the most advanced, in Europe. The general impression is that Sweden and Finland tend to lead, followed by Denmark and Norway.[7] The next section analyses how policy (and in particular innovation policy) has contributed to the development of the Nordic innovation systems.

[7] It is possible that the difference in innovation activity between Sweden and Finland on the one hand and Denmark and Norway on the other hand is smaller than some of the indicators presented here may suggest. In contrast to the practice in most other countries the innovation surveys in Denmark and Norway have been conducted as combined R&D and innovation surveys. It has been suggested (Wilhelmsen 2014) that this may bias the reported innovation activity downwards (as non-R&D based innovation would tend to be underreported). A separate survey conducted by Statistics Norway in 2013 to examine this possibility seems to confirm that suggestion (Statistics Norway 2014). The results indicate that innovation activity in Norway is closer to the Finnish and Swedish level than earlier surveys would suggest.

3. Innovation policy in the Nordic region

This section analyses the evolution of innovation policies – or policies affecting innovation - in the Nordic region, based on the existing literature on the subject. In each case we start by analyzing the origins of the innovation system, with a particular focus on the interaction between leading sectors of the economy, the emergence of external R&D providers and policy. We then analyze important policy challenges that have emerged, the responses to the challenges by policy-makers, the resulting changes in policy and the organizations associated with it and, finally, the current policy stance.

To conduct the analysis we searched for comprehensive studies of the Nordic innovation systems and/or innovation policy. In the case of Sweden the study is to a large extent based on the very thorough report on the Swedish innovation system produced by the OECD in 2013 (OECD 2013). A similar study is available for Norway as well (OECD 2008). We also benefitted from consulting the analysis of the evolution of the Norwegian innovation system in Fagerberg et al (2009a,b) and the extensive discussion of Norwegian innovation policy in Spilling (2010). In the Finnish case a thorough evaluation (in two volumes) has been carried out by a panel of experts led by Veugelers (Evaluation 2009). Our account is based on their reports supplemented by a recent study by Miettinen (2013). Despite an extensive search no study of similar relevance and breadth was found in the Danish case. The above studies were in several cases supplemented with information from other sources, published or available through the web, to highlight particular issues.

Sweden

As the other Nordic countries Sweden largely missed "the first industrial revolution". Its major export sectors, e.g., forestry and mining, continued to be based on exploitation of natural resources. However, in contrast to this bleak performance, Swedish firms were quick to exploit the opportunities offered by "the second industrial revolution" around the turn of the twentieth century, based on innovations in production, distribution and use of electricity and oil (Edquist and Lundvall 1993). A number of firms, some of which (ABB and Ericsson for example) grew very large and became global players, emerged during these years in industries such as telecommunications, office machinery, electrical domestic equipment and transport equipment. Subsequently an important pharmaceutical industry also materialized.

Swedish innovation policy during the "golden age" of "the Swedish model"

With hindsight the decades preceding the slump in the global economy in the mid-1970s may be seen as a "golden age" for the Swedish economy. Industrially the country was far ahead of its Nordic neighbors and arguably among the world leaders in many industrial areas. A characteristic feature was a very high level of R&D investments as a share of GDP, one of the highest in the world. As in other countries with high-R&D intensities the main source of this was investments made by private firms, particularly a number of large, internationalized companies. Nevertheless, public R&D investments, although small compared to those of the private sector, were also high by international standards, reflecting the broad consensus in Swedish society about an R&D-based growth path. These public R&D investments were concentrated in the university sector, which hence became pretty large. Thus two important pillars of the Swedish innovation system were a cluster of R&D-intensive, large firms and a strong university sector that served these firms with highly skilled labor and other services. The third pillar of the Swedish system, to be discussed below, was the state's proactive role in promoting innovation in selected areas.

"The Swedish model" is often used as a short hand for the close cooperation between big business, labor unions and the state that influenced Swedish politics and the social and economic development of the country from the 1930s onwards. A central goal for this cooperation was to increase productivity so that both healthy profits and increasing welfare for the population could be achieved. Technological progress, naturally, was seen as crucial for realizing this goal, and quickly attracted the attention of policy makers. A technical research council (TFR), the first of research council in Sweden, was set up in 1940. It was succeeded in 1968 by STU, literally the "board for technological development" and later, in 1991, by NUTEK (the directorate for industrial and technological change). A characteristic feature of Swedish science, technology and innovation was a strong emphasis on supporting university R&D, particularly in areas which policy-makers considered to be of high political and economic importance, such as nuclear energy or telecommunications. In addition, a major effort was made to engage the large, technologically advanced Swedish firms in (infrastructural) projects initiated by the state, of which is the cooperation between the firm Ericsson and the Swedish telecommunication agency (Televerket) about the developments of digital switches (the AXE system) may serve as an example. Hence, during this period, the state played a quite proactive role in fostering innovation and the technological capabilities underpinning it.

Economic frustrations and changes in the policy stance

The rapid economic growth during the "golden age" came to a halt towards the end of the 1970s and in the decades that followed Swedish economic development was characterized by slow growth,

structural problems (in shipbuilding for example) and, from the early 1990s onward (when Sweden underwent a financial crisis), relatively high unemployment. "The Swedish Model", which had been seen as big asset by many both in Sweden and elsewhere, was now generally regarded as a liability. The view that direct government involvement in industry of the type practiced in Sweden, "picking winners" as it was called, was counterproductive gained currency almost everywhere. Hence, the type of innovation policy pioneered in Sweden – characterized by extensive public-private interaction – increasingly became out of tune with the neo-liberal rhetoric that dominated politics all over the western world around the turn of century. The privatization of public infrastructure providers, such as Televerket, and new competition legislation mandated by the European' Union's "internal market", also made the innovation model based on public-private interaction pioneered in Sweden more difficult to pursue, and - as a consequence - the practice was largely abandoned.

Swedish innovation policy, from the 1990s onwards, gradually moved away from the strong sectoral focus which had characterized it in earlier decades. However, the strong emphasis on universities, and their R&D capabilities, as crucial inputs to firm-level innovation was retained or even strengthened. Policy aimed at supporting excellence in university R&D and strengthening the links between the university sector and private companies, often through various types of "centers" (in universities). The focus on linkages between the different actors in the system was of course consistent with the "national systems of innovation" approach which gained currency among both scholars and policy-makers during the 1990s, so much in fact that it gave name to VINNOVA, the Swedish Governmental Agency for Innovation Systems, which was established in 2001 as a new framework for some of NUTEK's previous activities. In addition to supporting excellence in university R&D and interaction between firms and universities VINNOVA also places emphasis on supporting innovation activities in small- and medium sized enterprises (SMEs), which receives about half of VINNOVA's funding. A more recent addition to the Swedish innovation policy flora also supporting small firms and entrepreneurship is "Tillväxtverket" - The Swedish Agency for Economic and Regional Growth – established in 2009. As the name suggests this agency, which also grew out of NUTEK, distinguishes itself from VINNOVA by having a clear regional focus.

Challenges for governance

As noted by the OECD (2013) the Swedish Innovation Policy landscape today contains many public actors, from rather large to quite small, that in various ways influence innovation. In addition to the innovation-promoting agencies mentioned above, there exist a number of research-supporting bodies, the biggest

of which is VR (literally the Science council) with a budget of about 4 billion SEK, twice as much as VINNOVA, which is the second largest of these organizations in terms of annual budget. VR covers all areas of science, and the funding mainly goes to the largest and most prestigious universities in Sweden. The smaller, more recently established universities can also seek R&D support from a special organization created for this purpose: the KKS (the Knowledge Foundation). In addition, there are a number of other smaller funding agencies, each with its own specialized profile, from, for say, environmental/sustainability issues via health to working life and social issues.

More could be said about the various organizations involved in supporting innovation in Sweden in one way or another but for our purpose the above will have to suffice. However, it is worth emphasizing that the fact that there are so many public organizations in this area – according to the OECD Sweden outperforms all comparable countries in this respect by a wide margin (OECD 2013)– reflects that the Swedish governance system in this area is indeed quite fragmented. Several ministries are involved, the two most important being the Ministry for Education and Research and the Ministry of Enterprise, Energy and Communication. While the former has the main research council (VR) within its portfolio, the latter is responsible for VINNOVA. In addition the Ministry for Health and Social Affairs and the Ministry of the Environment both have their own research funding bodies. Moreover, the focus of most of the ministries and the organizations within their responsibility tend to be squarely on research, which although a vital part of a national innovation system, is not identical with innovation. The weak emphasis on innovation – and innovation policy – among Swedish policy-makers is also noted by the OECD which observes that not even the ministry responsible for VINNOVA mentions innovation as one of its (nine) key responsibilities (OECD 2013, p.224) .

Nevertheless, the fragmented nature of governance and policy implementation in this area surfaces from time to time as a challenge for policy-makers, and there have been some attempts to develop practices or policy instruments that overcome the problem. One such instrument is the Research and Innovation Bill to Parliament, which is coordinated by the Ministry for Education and Research. The focus here, however, is mainly on providing broad guidelines for public investments in research, how these should be spent (priorities) and how the results may be exploited so that the benefits to society from these investment are maximized (e.g., commercialization). In recent years, increasing investments in public R&D has been a priority of the government, reflecting its support for the R&D-driven growth path that has been a characteristic feature of the Swedish economy for a long time. The latest bill, for the period 2013-2016, in addition gives priority to research in the life sciences, arguably a policy

response to the sharp reduction of private R&D in Sweden in this field in recent years, following a series of foreign takeovers of large Swedish pharmaceuticals firms.

Another attempt to provide a better coordination of policy in this area is the "national innovation strategy" coordinated by The Ministry of Enterprise, Energy and Communications. The first attempt, published in 2004, advocated a broad approach to innovation policy and called for cooperation between major stakeholders in this area in the creation of a strategy for the future. To implement this idea an "Innovation Policy Council" was created, however, after a short while the idea was abandoned, and it is not clear that it in practice mattered much. A second attempt by the government to formulate such a strategy – termed "The Swedish Innovation Strategy" – surfaced in 2012. As the first version it advocates a broad approach to innovation policy and, commendably, pays homage to the grand societal challenges facing society such as climate change. However, the strategy is suitably unclear with respect to how this should be implemented in practice.

Norway

Throughout its history Norway's economy has depended on exploitation of natural resources. Until the end of the nineteenth century fishery, forestry, mining and agriculture were the most important.[8] In the early twentieth century hydroelectric energy, based on Norwegian waterfalls, created the basis for new, energy-intensive, export-oriented industries producing metals, chemicals, pulp and paper, fertilizers and so on. Closer to our own time, from around 1970 onwards, an oil and gas sector based on exploitation of resources on the Norwegian continental shelf developed.

The origins of the Norwegian innovation system

A knowledge-infrastructure catering for the needs of important industries slowly evolved. A mining college was established already in the 18th century, well before the country's first university, established in Oslo in 1811. An agricultural university was founded in 1859 and a public research organization focusing on ocean and marine research in 1900, both before the establishment of the country's first technical university, NTH, in Trondheim in 1910 (a century after neighboring Sweden got its first technical university). At that time the development of the new, electricity-intensive industries were already under way, and NTH – and consulting activities by its academic staff - came to be an important source of knowledge and skills for their subsequent development. Several specialized research institutes serving the needs of particular industries, such as for example the pulp- and paper

[8] Another important industry, not directly based on natural resources but on Norway's long coast line, has been the shipping industry.

industry (PFI, established in 1916), also emerged. In general, Norwegian industry, particularly the natural-resource-based part, preferred to buy services from the PROs rather than investing heavily in internal R&D. As a result the share of R&D in value added in Norwegian industry became relatively low compared to other developed economies while the PROs or "institute sector" grew rather large. This unusual pattern was strengthened with the rapid growth of the Norwegian oil and gas industry, and the derived demand for knowledge and expertise, from the 1970s onwards, giving rise to an expansion (and reorientation) of the Norwegian PROs to meet the needs of the new industry. Today, the largest of these is NTH's consulting arm SINTEF, established in 1950, with more than 2000 employees.

Modernization

The high dependence on natural resources - and the perceived need to develop a more advanced, knowledge based industry as a substitute or complement to the natural resource-based sector – has been a recurrent theme in Norwegian politics. After the Second World War several influential politicians within the then ruling Labor Party advocated the view that Norway needed to develop a strong presence in the new science-based technologies of the time and the industries they had given rise to, such as electronics, telecommunications and atomic energy. In order to tilt the economy in that direction an elaborate system, with the newly created technical research council (NTNF, established 1946) at its core, was created by the Ministry of Industry in cooperation with other ministries. Other important elements of this system were a series of governmental research institutes in areas such as defense (FFI, 1946), atomic energy (IFE, 1948) and telecommunications (TF, 1967) as well as parts of NTH and its consulting arm SINTEF. A number of firms, some of which newly created, were also involved, and for a while the system appeared quite dynamic. Moreover, the increasing emphasis on R&D (and R&D support) as a useful (and perhaps necessary) policy instruments influenced other ministries, which to a varying degree took steps to develop a supporting knowledge infrastructure in their own fields. Hence, a research council for agriculture emerged in 1946, a general research council in 1949, a research council for fishery in 1972 etc. Thus around 1970 the Norwegian innovation system had acquired a number of distinct features. This included a relatively large "institute sector" (the PROs) with substantial public funding serving various industries and parts of government with knowledge and expertise. A relatively large and diversified "research council sector", among other things supporting the PROs and their interaction with private firms, had also emerged.

Problems emerge - changes in the policy stance

The drive towards modernization ran into problems around 1980. First, the emphasis on electronics etc., while leading to a number of scientific achievements, did not translate into a lasting industrial success.

On the contrary the companies that took part in the modernization drive started to falter one by one, and today Norway does not any longer have large firms in the electronics and telecommunications industries. Even the major state owned defense firm, KV (Kongsberg Våpenfabrikk), a cornerstone in Labour's efforts, went bankrupt and had to be reorganized. Second, trade liberalization and globalization made it more difficult for government to influence industrial development, for example sheltering "national champions" in selected industries from foreign competition. The wisdom of doing so was also questioned, as it was argued that it might just delay (necessary) structural changes and thus lead to social losses. In short, as in other countries, neoliberal ideology was advancing, stressing the limitations of government and the virtues of free markets, undermining the legitimacy of the activist state-led approach adopted by Norwegian policy makers in earlier years.

One consequence of these changes was that many previously state-owned research institutes were "privatized" and given greater responsibility for their long term survival. The problems that this might have created were cushioned by the rapid growth during these years of the oil and gas sector which became an important customer for many established institutes (such as SINTEF). Moreover, the various research councils were merged into one, NRF (Norges Forskingsråd), in 1993, in order to, it was argued, making the system more efficient and eliminating redundant (overlapping) activities. However, the organizational set-up of the new council reflected to a large extent the earlier structure. Although NFR was owned by a single ministry (nowadays the "Knowledge ministry" responsible for research and education), the other ministries continued to be responsible for research within their respective areas, which implied that the council had to negotiate with each individual ministry about what to do. This procedure, the so-called sector principle, meant that the council often had little leverage when it came to make decisions about what to do. Hence, the individual ministries continued to exercise considerable control of the research priorities in their respective areas. To a large extent, rather than shaping priorities and advising government, the new council turned into an executive body for the individual ministries, the most important of which are today the "Knowledge ministry" and the Ministry of Trade and Industry.

The 2000s

The innovation system approach, with its holistic perspective, was slow to penetrate the thinking of Norwegian policy makers. However, around the turn of the millennium innovation started to get more attention by policy makers and concepts such as "national innovation system" and "holistic innovation policies" became part of their vocabulary. The clearest evidence of this change was the plan for "a

holistic innovation policy" developed by the Ministry of Trade and Industry and published in 2003. This plan described a concerted effort for increasing Norwegian innovation, including national as well as regional elements. It also emphasized the need for active coordination among stakeholders and between different parts of government.

Several important changes in the government's way to conduct innovation policy took place in the early years of the new millennium. In 2002 a dedicated "Innovation Division" was created within the research council to support R&D activities in firms, among other things through so-called "user-governed" R&D projects co-financed by firms and the council, a policy instrument inherited from the Division's precursor, the technical research council (NTNF). This also holds for a number of targeted programs – to some extent located in other part of the council's organization structure - supporting interaction between firms and PROs in areas such as ICT, oil and gas, fishery etc. A new initiative by the council was the establishment of a number of "centers for research-driven innovation" (SFI) – temporary centers of excellence co-financed with industry - in prioritized areas (resembling the already existing "centers of excellence" – SFF - that the research council had promoted for some time already).

In 2002 the government also introduced a new scheme for subsidizing firm-level R&D ("Skattefunn"). In theory this is a tax-credit, but since most of the firms that apply for support pay very little tax (if at all), the major part of the support is paid out as a subsidy. An important feature of the scheme is a strong incentive for firms to cooperate with external R&D providers, e.g. the PROs, which hence benefit financially from this arrangement. In budgetary terms it is the largest among the government's innovation policy instruments (Fagerberg 2009). However, only a small minority of Norwegian firms applies for such support, may be because most of them do not see themselves as R&D performers, or because there is a (rather low) cap on the subsidy which makes it much more attractive for small firms (and for firms with little R&D).

Two years later, in 2004, the government created a new organization, named "Innovation Norway" (IN, Innovasjon Norge), through a merger of several existing public bodies providing economic support and services to industry, particularly in rural areas. However, despite the name, most IN's budget goes to subsidizing activities in rural areas (and/or primary industries) regardless of the innovation content of the supported activities (Riksrevisjonen 2008). It is possible that the government at the time considered the naming of the new organization to be a first step towards transforming it into a more powerful innovation actor, comparable to TEKES in Finland or VINNOVA in Sweden. However, in 2005 Norway got a new centre-left government, which – when faced with criticisms of Innovation Norway's profile –

defended its ambiguous profile by stating that innovation was only one among several objectives for the organization. The centre-left government also abandoned the previous government's attempts to establish forums for coordination about innovation policy among stakeholders and across different parts of government.

As a result Norwegian innovation policy today appears segmented, poorly coordinated and in lack of credible public innovation actors endowed with sufficient authority, competence and resources.[9] However, at the time of writing a new (right-wing) government has taken over. To what extent the new government will change the policy stance in this area remains to be seen.

Post-oil?

Since the 1970s the oil and gas industry has grown to become Norway's major export sector and an important source of income for both the government and the population at large. As a consequence Norwegian wage-levels are now far above the other Nordic countries (while unemployment is much lower than elsewhere). The Norwegian innovation system, and not the least the "institute sector" (which is the largest recipient of funds from the research council, well above the universities), has contributed significantly to this success story by adapting to the growing industry's need for knowledge, skills and expertise (Fagerberg et al 2009a,b). But will the happy days continue? Concerns about the damaging effects of emissions from burning fossil fuels are mounting, and although global efforts to curb the emissions have not been successful so far, the possibility of this happening raises questions about the sustainability of the country's present development path and, arguably, what policy instruments might possibly contribute to tilt the economy in a more sustainable direction. From such a perspective innovation policy might be highly relevant to consider.

Finland

Compared to its neighbors Finland is an industrial late-comer. Activities based on exploitation of natural resources, particularly agriculture and forestry, dominated the economy at least until the 1970s. However, subsequently Finland entered a period characterized by high growth, fast structural change and rapid increase in R&D investments with the consequence that Finland today is recognized by the EU as one of the "innovation leaders" in Europe (Innovation Union Scoreboard 2013). Innovation policy, broadly defined, came to play an important role in this transition.

[9] See Spilling (2010) for a discussion.

The origins of the Finnish Innovation System

As in several other countries key economic sectors and a "knowledge infrastructure" catering for the needs of these sectors co-evolved over many years. Public research organizations (PROs) addressing the needs of the powerful agricultural and forestry sectors emerged already before the 2nd World War. These organizations continue to be among the largest PROs in Finland. The 2nd World War gave rise to a new organization, VTT (The Technical Research Centre of Finland), supporting the Finnish war effort and the manufacturing base on which it depended. After the Second World War VTT ventured into a number of technological fields of relevance for the Finnish manufacturing industry, its transport sector, construction, energy provision etc. Currently VTT has around 3000 employees, and on its website it prides itself of being "the biggest multitechnological applied research organization in Northern Europe"[10]. In the course of time several other PROs have been established by different parts of government to address issues of relevance for them. These organizations, and particularly VTT, continue to be important providers of knowledge-based services to Finnish firms, and their role has become a characteristic feature of the Finnish national innovation system. Although nowadays many of them, such as the VTT, get most of their income from customers, they also receive substantial economic support from (various parts of) government.

After the Second World War many countries started to pay more attention to the important role played by science and tertiary education for long run economic development and Finland, although not among the forerunners, was no exception. A public organization dedicated to supporting scientific research - The Academy of Finland – was established in 1961. Moreover, the number of universities - and the volume of tertiary education – expanded rapidly in the years that followed, with the consequence that the educational standard of the Finnish labor force improved significantly and today is among the highest in the world. Emphasis has also been placed on the development of primary and secondary education, with a particular focus on the qualifications of teachers, and according to the so-called PISA-tests Finnish 15-year-old students rank among the best in the world in reading, mathematics and natural science (Miettinen 2013). Public R&D investment also increased and is currently among the highest in the world when measured as a share of GDP. Nevertheless, despite these achievements doubts have been expressed recently about the quality of Finnish science (Evaluation 2009), and an effort to increase the quality of Finnish research has become a central element in Finnish (innovation) policy in recent years, see below.

[10] http://www.vtt.fi

New public innovation actors: SITRA and TEKES

A characteristic feature of Finnish innovation policy is the sustained focus on supporting structural changes in the economy away from the initial specialization in natural-resource based products, especially forestry, which for a long time dominated the country's exports. During the 1960s and 1970s several steps were taken to achieve this goal. In 1967 an independent public body supporting technological research, SITRA (The Finnish Innovation Fund), was established (as a part of the Bank of Finland).[11] Finnish policy makers decided to give priority to the electronics and telecommunication industries, and during the 1970s several initiatives were taken to support the development of national technological capabilities in these areas. In 1983 a new public organization, TEKES (The Technological Development Center), was created to support this process. The political weight attached to TEKES' mission may be illustrated by the fact that its budget expanded rapidly and soon surpassed that of its older (basic research) counterpart, The Academy of Finland. It is also noteworthy that the rapid increase in TEKES' budget continued in spite of the crisis in the Finnish economy around 1990, which resulted in a large drop in GDP and soaring unemployment, and led to significant budget cuts in many areas. In the 2000s TEKES' budget, of which about two thirds goes to firms and the remaining third to universities and PROs, had become twice as large as that of the Academy of Finland.

A system perspective on governance emerges

Finnish policy makers were quick to embrace the new, holistic understanding of innovation which emerged around 1990 under the label "national innovation systems". An important vehicle for the diffusion of the NIS approach became the "Science and Technology Policy Council of Finland", which was renamed "Research and Innovation Council" in 2009 as part of the adoption of "Finland's Innovation Strategy" that year, see later. The council, chaired by the Prime Minister, is an advisory and coordinating body for research, technology and innovation policy, consisting of representatives from relevant ministries, public innovation actors (such as TEKES, VTT and the university sector), major firms, business associations etc. and meets regularly. It also develops plans for the development and implementation of innovation policy in Finland and publishes every 3-4 year a "review" devoted to these issues.

Miettinen (2013) has analyzed the development of these "reviews" since the early 1990s. The analysis shows that in the 1990s the focus was on strengthening public-private interactions, making the system more effective and – above all – increasing national investments in R&D which was seen a prerequisite for the development of a competitive, high-income, knowledge-based economy. More recent versions

[11] SITRA still exists but functions more as a strategic think-thank than as a distributor of funds (see Evaluation of the Finnish National Innovation System – Full Report, p. 25).

of the review has broadened the perspective on innovation with respect to what it is about (including so-called "social innovation" for example), where it takes place (not only in "high-tech"), how innovation may be encouraged (including demand- and user- driven innovation) and what it is relevant for (for instance the public sector as well). This broader perspective was also embraced by "Finland's national innovation strategy" which was suggested in 2008 by a committee appointed by the Ministry of Employment and Economy and led by the then President of SITRA. The committee among other things suggested making innovation policy a more central part of general economic policy.

Recent trends

In recent years the Finnish government has taken several initiatives to reform the national innovation system. The underlying rationale for these changes appears to be the argument that in a globalized world it is essential for a country to develop a limited number of centres of excellence that can function as global hotspots and points of attraction for skills and resources. These initiatives include a reform of the Finnish university system, through which the individual universities get greater independence, and the creation of a "world-class top university" in Finland – The Aalto University - through a merger of three universities in the Helsinki area.[12] These reforms have been criticized by Miettinen (2013) for having a democratic deficit. While, he argues, previously large reforms were prepared by committees with broad societal participation, more recently policies have often been shaped by more narrow groups of people hand-picked by the government or individual ministries.

Another initiative has been the creation of a number of so- called "SHOKs" (Strategic Centers for Science, Technology and Innovation) focusing not only on electronics but also on traditional industries such as forestry and metals. The SHOKs are (temporary) centres of excellence financed by industry, i.e., large established firms, and the government (TEKES).[13] However, the panel of experts that evaluated the Finnish National Innovation System, while embracing the university reform, had a more critical evaluation of the SHOKs, which they considered might contribute to conserve the country's industrial structure, rather than supporting novel initiatives in new areas, which they saw as equally if not more important (Evaluation 2009).

[12] These were the Helsinki University of technology, the Helsinki Business school and the University of Arts and Design

[13] In Finland innovation policy is also a central element of regional policy, and this includes among other things the establishment of a series of «Centers of expertise». These will not be discussed here. See Evaluation (2009) for a discussion of this issue.

Finnish innovation policy has been characterized by a strong focus on the electronics industry. The prime success story has been the firm NOKIA, which in an amazingly short time transformed itself into a global telecommunications giant. However, in recent years the company has struggled, many jobs have been lost, and recently its consumer division was sold to Microsoft. Do these experiences imply that the focus of policy and its implementation needs to be reconsidered? This is no doubt an issue that will be discussed in Finland in the years ahead.

Denmark

Historically Denmark has been a predominantly agricultural economy, and the main export product was grain. However, over the years the share of processed agricultural products (bacon, meat, cheese etc.) in production and exports increased, and by the early 1900s most of Denmark's exports consisted of processed products. During the twentieth century Danish industry successfully ventured into a number other areas such as pharmaceuticals, medical instruments and environmental technology. R&D investments also increased, not the least in the private business sector, and Denmark is now one of the top performers in Europe when it comes to R&D (Figure 3).

The origins of the Danish innovation system

The large and economically important agricultural sector is an important pillar of the Danish innovation system, and a set of organizations supporting the development of this sector evolved from the 18th century onwards. An association supporting technological change in agriculture (Det Kongelige Danske Landhusholdningsselskab) was formed in 1769. Local associations all over Denmark subsequently followed. The association(s) supported the development of extension services (so-called agricultural consultants, employed by the local associations), as well as the creation of agricultural colleges, the first of which was established in 1837. The colleges became from the mid-1800s onwards supplemented by a large number of so-called "folk high schools" providing basic training to (young) people from (mainly) rural areas. At the national level a Veterinary Institute was established in 1773, and in 1856 it was decided to expand it into an agricultural university (Landbohøjskolen). Most of these organizations continue to exist although some changes have of course taken place over the years, for example, in 2007 the agricultural university was merged with the University of Copenhagen.

Another strong pillar in the Danish system is provided by its universities. The University of Copenhagen, established in 1479, has for centuries been one of the hotspots for science and higher education in the

Nordic area. In 1829 an engineering college was established as part of the university and subsequently developed into an independent technical university (The Technical University of Denmark, DTU). Several other universities were also established over the years, mostly after the Second World War. Today Danish Universities are renowned for high quality research. Articles published by Danish scientists on average attract more citations in prestigious scholarly journals than works written by scientists from other Nordic countries. Several Danish scientists have also been awarded Nobel prizes for their work.

Research and innovation policy in the Danish context

Traditionally, Danish politicians have been much more concerned about research than about innovation, although over the years the latter has got increasing attention.

A number of research councils, reflecting disciplinary and sectorial divisions, were established in 1968 and a technical research council followed four years later, in 1972. These councils received funding from different ministries; hence the system became quite fragmented and a need for better coordination appeared. Various attempts were made over the years to create specific organizations to take care of this need. However, a Ministry responsible for both the research councils and the research at the universities – the Research Ministry (Forskningsministieriet) – did only emerge in 1998.

During the 1990s Danish policy makers came to place more emphasis on supporting excellence, among other things through the creation of a new fund for basic research in 1991, which financed temporary centres of excellence in a number of areas. Moreover, especially from the mid 1990s onwards, Danish policy makers begun to channel a part of the public R&D funding to areas of high priority. These included areas of traditional strength, such as food, biotechnology, nutrition and health, but also environmental technology, new materials and ICTs. A substantial share of public R&D funding, estimated to be around 35-40 per cent of the total (DEA 2011), went to these areas. Questions related to knowledge transfer, public private interaction and commercialization also started to attract more attention from policymakers. Thus, although couched as research policy, several policy instruments that in other contexts might have been seen as associated with discussions about innovation policy, emerged on Danish policy makers' agendas around the turn of the century.

During the first few years of the new millennium a number of changes took place. First the Ministry of Research was relabeled "Ministry of Science, Technology and Development". Then – in 2002-2003 - a

reform of the research council structure took place. The new structure included several councils for basic research, a "Council for Strategic Research" and a special "Council for Technology and Innovation" (as a successor to Technical Research Council). Hence, the "I"-word was now firmly established in the Danish policy vocabulary. Since its creation the council has produces a series of ambitious action plans (with concrete targets) for how to increase innovation activity in Danish firms, industries and sectors. In 2004 a new fund, "The Danish National Advanced Technology Foundation", intended to tilt the Danish economy in a "high-tech" direction by investing risk-capital in new promising high-tech ventures, was added to the research council portfolio. In addition, a "Danish Growth Foundation", providing risk-capital for innovative businesses in cooperation with similar organizations at the regional/local level, was established by the Ministry for Business and Growth in 2006.

The "globalization strategy" and beyond

In 2006 the then Danish (centre-right) government published its "globalization strategy" about how to retain Denmark's position as one of the best places to live and work in a world characterized by increasing global competition. Although it was noted that "failing to innovate, it may be difficult to maintain Denmark's position as one of the world's wealthiest countries" (p.7), there was little discussion in the document of how innovation might be encouraged and seemingly no attempt to take into account the findings from international research on this topic from the last fifty years or so. Rather the main focus was on "improving the efficiency of public spending on education and research, in particular by allocating more public funds in open competition, and on increasing competition and internationalization in the Danish economy as a whole" (ibid). The stated goal was that "Denmark should be the world's most competitive society by 2015" (p. 17) assuming – probably – that this would be sufficient for elevating innovation as well. The government also embraced the European Union's 3 % target for R&D as percentage of GDP, with a third of this coming from public sources. As a result public investments in R&D grew quickly in the years that followed, and in contrast to many other EU member countries Denmark actually met the target (at the end of the decade as envisaged).

Consistent with the "globalization strategy" important changes took place in the university sector after the turn of the millennium. A new university law from 2003 introduced new forms of governance and a stronger emphasis on the so-called "third mission"(i.e., knowledge transfer and commercialization). During 2006-2007 a major reorganization of the sector took place and a number of universities were merged so that the number of Danish universities dropped by one third (from 12 to 8). In addition,

public research organizations outside universities did in most cases lose their independence as they were merged with the universities.

Recently, Danish policy on innovation has taken a new twist.[14] In October 2013 the government announced an agreement between the main political parties on the creation of a "large new innovation foundation" through the merger of three existing organizations, namely the "Council for Technology and Innovation", the "Council for strategic research" and the "Advanced Technology Foundation". The new foundation is planned to have an independent board and be at "arms-length of the political system". It is envisaged to have a budget of DKK 1,5 Billion, i.e., about the same level as the Swedish VINNOVA but substantially less than its Finnish counterpart, TEKES. The new innovation foundation is still not in operation and what role it will play remains to be seen. Potentially, however, this may be a step towards the creation of a more powerful innovation-policy actor – and more effective innovation policy – in Denmark.

4. Concluding remarks

This section sums up some of the lessons from the discussions in the previous sections and points to issues in need of further research.

In section 2 of this paper the innovation systems in the Nordic countries were compared to systems elsewhere in Europe along a number of dimensions reflecting innovation performance, the working of the innovation system and access to capabilities and resources of importance for innovation. The analysis showed that the Nordic innovation systems are among the most advanced in Europe. This achievement is arguably related to a broad set of policies pursued over a number of years, not the least with respect to education and gender equality, as well to the prevalence of norms and attitudes conducive to innovation and diffusion of technology (Fagerberg 2010). However, a more thorough treatment of these issues is beyond the scope of this paper (see Dølvik 2013 for an extended discussion).

The analysis in section 3 revealed that the historical origins of the various Nordic innovation systems matter for how innovation policies subsequently developed. For example, the countries with well-developed university systems over a century ago, i.e., Denmark and Sweden, have developed innovation policies in which universities play a very central role. This is still the situation. In contrast, Finland and Norway - younger nation states with less-well developed university systems a century ago – developed

[14] http://fivu.dk/en/newsroom/press-releases/2013/large-new-innovation-foundation-to-solve-societal-challenges-and-create-jobs

systems in which public research organizations outside universities – the "institutes"- became large and powerful actors in the innovation system. This continues to be the case today. For example, Finland's leading PRO – VTT – has around 3000 employees, and in Norway the "institutes" collectively get more funding through the research council than the universities do. Hence, for historical reasons innovation systems differ a lot, and this needs to be taken into account when designing and implementing policy. A mechanical transfer of so-called "best practice" from one system to another may easily do more harm than good.

In this paper we have adopted a broad definition of innovation policy which includes all policies (and policy instruments) that affect innovation performance (in a non-trivial way). From this perspective it is evident that the phenomenon innovation policy is older than the term. How far back in history innovation policies can be traced is not an issue that we will discuss here. However, it is evident that a lot of what was attempted in Sweden, Norway and Finland during the post-war period under labels such as "science policy", "technology policy" and "industrial policy" might just as well have been labeled "innovation policy" (and probably would have got that label today). Some of these policies had a significant impact, while others can probably be categorized as failures. There may still be a lot to learn from such past policy experiments, which deserve further study.

Particularly in Sweden, but to some extent in Norway as well, quite ambitious policies were pursued during the 1960s and 1970s aiming at supporting and strengthening the role of "high-tech" industry, e.g., telecommunications and electronics. Finland adopted this agenda later, i.e. from the 1980s onwards, and arguably with even greater force (and better results?). Although «targeting» increased in Denmark as well during the 1980s and 1990s, this was more limited in scope. Why Danish policy developed differently from the other Nordic countries is an interesting question which we cannot consider in the necessary detail here (see however Asheim and Mariussen (2010) for a take on this issue).

The last few decades have witnessed important changes in how innovation policy is conceived, organized and carried out in all four countries. To some extent the trends are similar: There has been an increasing attention to innovation as an important object for policy everywhere in the Nordic area. Moreover, new organizations within the public sector devoted to supporting innovation have been created in in all four countries, such as TEKES in Finland (1983), VINNOVA in Sweden (2001), The Norwegian Research Council's Innovation Division (2002) and Innovation Norway (2004) in Norway, and The Council for Technology and Innovation (2002-3) and the new Innovation Foundation to be set up in 2014 in Denmark. However, Finland stands out by having much more ambitious policies, much greater

involvement of the political leadership of the country and other important actors in the policy process, and a much more powerful and well-funded innovation agency (TEKES). Why this is the case, what the consequences are and what can be learnt are interesting and relevant questions that we cannot consider in the required depth in this paper but which certainly deserve attention.

Nevertheless, it is interesting to note that Finnish policy makers were early movers with respect to adopting the new "innovation system" approach to policy that started to diffuse around 1990. This new and more holistic approach placed strong emphasis on the need for policy coordination. Finland is unique among the Nordic countries in having a policy coordinating body on technology and innovation policy led by the prime minister. The innovation system approach also had some influence in Sweden, and its adoption led as mentioned to the formation of VINNOVA 2001. However, as noted by the OECD (2013), VINNOVA is not as well endowed with resources as TEKES, there are many other relevant actors in the Swedish setting, coordination is weak and innovation policy does not appear to be an important topic on the government's agenda. The latter by and large also holds for Norway, which despite the creation of new, large agencies in this area has developed a very fragmented system with little if any coordination among the relevant ministries (Fagerberg 2009). In Denmark it is difficult to trace much influence of the innovation system approach on policy discussions, and innovation policy appears – until recently at least – not to be regarded as a central issue. Why the new ideas on systems and policy have spread so unevenly in the four countries under study here is an intriguing question.

However, writing about innovation policy in the Nordic area is like shooting at a moving target. For example, Denmark is in the process of getting a new, potentially much more powerful innovation agency. Norway just had elections and it is possible that the new government will place more emphasis on innovation policy. Sweden is going to have an election, and there are some indications of increasing attention to the topic there too. So interest in innovation policy is probably not going to go away. A possible future path might be one with a greater emphasis on the potential contribution of innovation policy to the solution of grand challenges, e.g., the climate challenge, as suggested by the OECD in its advice to both the Swedish and the Norwegian government (OECD 2008, 2013). "New" topics, such as innovation in the public sector, "social innovation" and the roles of work organization and social security systems for innovation (Lorenz 2013), may also get more attention.

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