Report
2011:04

The Performance and Challenges of the Swedish National **Innovation system**

– A background report to OECD

How can wealthy nations stay rich in a rapidly changing global knowledge economy? This question is of central concern for many small open economies like Sweden's. This report is commissioned by the Ministry of Enterprise, Energy and Communications and the purpose is to provide a first background analysis for an upcoming evaluation of Swedish innovation policy by the OECD.

growth analysis

File number 2011/211
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Foreword

How can wealthy nations stay rich in a rapidly changing global knowledge economy? This question is of central concern for many small open economies like Sweden's, and it is an important topic for The Swedish Agency for Growth Policy Analysis (Tillväxtanalys) to analyze and to spell out the implications for overall growth policy.

This report is commissioned by the Ministry of Enterprise, Energy and Communications and the purpose is to provide a first background analysis for an upcoming evaluation of Swedish innovation policy by the OECD, which is to be finalized in June of 2012.

This background report provides an overall analysis of the structure, conduct and performance of the Swedish innovation system using various indicators. The objective is to identify the innovative performance of Sweden in a comparative perspective and to assess strengths and weaknesses, which then can be subject to more detailed analysis in the course of the evaluation and for future policy analysis.

Sweden ranks highly according to a number of innovation league tables. But this indicator of strength of Sweden's National Innovation System (NIS) has been questioned by critics, who claim that even though Sweden scores highly on various input indicators (such as R&D), the Swedish system still struggles to convert this into economic gain. The report analyzes this and other claims about Swedish performance and concludes that these claims have tended to outlive new data and research. First, the use of various indicators for the period 1995 to 2010 suggest that there is no evidence of an overall poor Swedish performance regarding output when Sweden is compared with seven similar countries. Second, even if the supply and quality of innovation indicators have increased for policy analysis, indicators are still lacking when it comes to the precision and validity required to make broad claims about the innovativeness of the Swedish national system of innovations.

Even if Sweden has delivered comparatively well, there are weaknesses in the country's overall performance. The report identifies and discusses the existence of such weaknesses and spells out some of the resulting policy challenges.

The report is considered to be a work in progress and discusses several avenues for further analysis.

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Östersund, October 2011

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Summary

The purpose of the report is to provide a background analysis for an OECD evaluation on the conduct and performance of the Swedish national innovation system (NIS). The OECD evaluation will be presented in June 2012.

The objective of the background report has been to critically assess the performance and challenges of the Swedish innovation system in order to provide a platform for more specific analysis. Three overall themes have emerged.

First, we interpret evidence from different statistical sources that support the claim that the adaptation and performance of the Swedish NIS has been quite successful over the last 15 years. The allegations of a Swedish "paradox" seems to be based on either large (linear) expectations on the growth effects on the level of certain input factors, such as R&D, or an uncritical use of comparative innovation indicators which still have unclear linkages to overall business performance. Thus, several other ways of measuring and assessing Swedish performance are presented.

Secondly, we find evidence that Sweden's NIS has been reorganized in more complex value chains, which implies that the common propositions that "large corporations do not contribute the same amount as they did earlier" or "Sweden lacks in high technology exports" are not entirely true or at least reflect misconceptions about the structure and importance of value chains in the NIS. Assessing the performance of innovation in small, rich, open economies requires new frameworks, and a re-framing of challenges and various innovation policies when knowledge crosses technological, organization and geographical borders.

Thirdly, the abundance of combining new "innovation" indicators provides opportunities to detect areas where Sweden needs to reflect how to develop innovation policy. Our method of focusing on a small sample of peer countries suggests from whom we can primarily learn. Our conclusions are that Denmark can teach Sweden how to develop policies that spur entrepreneurship, while Switzerland, the Netherlands and Denmark together can inspire new ideas of how to develop our universities.

Sammanfattning

Syftet med rapporten är att granska det svenska innovationssystemets utveckling och fungera som en plattform och bakgrund till mer detaljerade studier. En sådan studie kommer OECD, på uppdrag av näringsdepartementet, att genomföra under 2011 och 2012 där syftet är att utvärdera och ge en översyn av den svenska innovationspolitikens innehåll och utformning.

Föreliggande rapport studerar vissa specifika delar av det svenska innovationssystemet med särskild betoning på näringslivets och universitetens forsknings- och innovationsverksamhet. En utgångspunkt har varit att problematisera och nyansera ett antal påståenden och myter om det svenska innovationssystemets relativa styrkor och svagheter. Studien bygger på användning av ett antal jämförbara indikatorer, olika former av internationell statistik och komparativ analys länder med liknande strukturella förhållanden och drag som Sverige. Resultaten visar på antal övergripande breda teman som kännetecknar den svenska utvecklingen.

- Vid en jämförelse mellan Sverige och sju andra länder finns inga belägg för att Sveriges innovationssystem presterar undermåligt. Snarare är situationen tvärtom vilket också bekräftar Sveriges höga placering i en mängd olika rangordningslistor på innovations- och konkurrensförmåga.
- Påståenden om förekomsten av en Svensk ”paradox” där Sverige inte får avkastning för höga FoU-insatser stämmer inte. Om det finns en svensk paradox så finns det också en dansk och en Schweizisk sådan. Förmodligen bygger sådana påståenden på analyser där Sverige inte jämförs med jämförbara länder, alternativt byggs dessa påståenden på förenklade (linjära) samband mellan vissa partiella indikatorer och innovationssystemet som helhet.
- Analyserna och tolkningen av innovationsstatistiken visar att Sverige och dess företag idag ingår i en alltmer komplicerad struktur av handelsutbyten något vi i rapporten kallar för globala värdekedjor. Att exempelvis använda graden av ”högteknologisk” export som en indikator på framgång i innovationssystemet blir därför otillräckligt och kan leda till felaktig diagnos om var svagheterna ligger i systemet.
- Ett exempel på en viktig länk i de globala värdekedjorna är det nära samspelet mellan tillverkning och tjänster, där de kunskapsintensiva tjänsteföretagen i hög utsträckning investerar i immateriella investeringar för sin innovativa utveckling.
- Det finns idag ett överflöd av internationella innovationsrelaterade indikatorer som ger nya möjligheter att spåra styrkor och svagheter i Sveriges innovationssystem. Rapportens ansats att jämföra Sverige med några liknande länder ger en indikation på att Sverige kan lära av Danmark beträffande snabbväxande företag samt Schweiz och Nederländerna samt Danmark kan ge idéer hur man kan utveckla universiteten.

1 Introduction

The purpose of this report is to provide a baseline analysis for an evaluation of Swedish innovation policy which will be conducted by the OECD in 2012, the results of which will be delivered in a final report in June 2012. The OECD report, as well as several other ongoing studies in Sweden, will provide analysis for the existing service innovation strategy and the upcoming National Innovation Strategy, and the Swedish Research and Innovation Bill, both to be presented in the second half of 2012.

This background report will describe and analyze some aspects of the structure, conduct and performance of the Swedish National Innovation System (NIS) in a comparative perspective. The main objective is to provide the OECD and others with a starting point and a platform for digging deeper into the various challenges, opportunities and problems that a rich export-based economy like Sweden is facing in a global knowledge economy.[1] This will be done by analyzing various indicators of the structure and performance of the Swedish NIS as well as reviewing and assessing some of the issues (and myths) that have been discussed in Swedish policy debates.

Innovation is an open system of high complexity and with many ill-understood feedback effects, particularly in world where knowledge is increasingly crossing technological, organizational and geographical borders. One serious problem is that there are no self-evident indicators which tell the policy maker when enough knowledge has been gathered for taking policy actions. The risk is therefore that policy is driven by myths and the use of one-dimensional indicators which increases the frequency of failure and unintended consequences. This report therefore takes a modest ambition to re-frame and re-interpret some aspects of the innovative performance of the Swedish Economy. The following two sections describe the methods used for conducting the re-framing.

It has not been possible to assess how the present global financial turbulence will affect the overall performance of the economy; the data used will primarily cover the period up to 2009. Due to the limited time frame the report focus on certain areas of the Swedish NIS and do not cover areas like the supply of skills via the education system and the supply of venture capital with of course are of importance for sustainable innovation.

The Table of Contents of this background report follows the structure of the terms and references agreed upon by the Ministry of Enterprise, Energy and Communications and the OECD (in June 2011).

1.1 Method of analysis

There is at present a rather rich set of data regarding partial indicators to measure the performance and efficiency of national innovation systems. For our purposes, a close and detailed analysis of various EU indicators of national innovation systems will be done as a complement to Swedish data. The report uses the concepts innovation and

[1] We will not discuss the definition of national innovations system or what constitutes innovation as the body of literature on this matter is extensive. In essence, we follow the definitions published by the OECD.

national innovation system, both have been used for a long time and the broad meaning with them is presented in Box 1.1. However we do not discuss the concepts in detail.

Comparative analysis of innovation systems is usually conducted comparing a single country with the median or average of all other OECD countries. Here we advocate for a systems perspective, meaning that a NIS should be assessed by comparing a specific NIS with other NIS from similar contexts. A system perspective need to consider the probability of a slow adjustment process in the system when there is no exogenous chock questioning the constituents of the system. Although at present the EU and the US struggles with fiscal debt problems affecting world aggregate demand we cannot say that this demands a different assumption regarding future adjustment in the NIS.[2] Given this assumption of "path dependency" we take as a point of departure, the following conditions as important in order to assess the Swedish NIS.[3]

- High tax rates and large public commitment. Sweden's tax rate of over 45 percent of GDP is second to Denmark among the OECD countries.
- A relatively small domestic market, high international dependency.
- The sum of export and import consists of a large variety of products. Sweden's international trade amounts to more than 50 percent of GDP. It seems reasonable to assume that globalization affects a country with high trade intensity more. Thus, countries with trade patterns similar to Sweden's probably ought to have similar challenges ahead.
- Influence from international businesses/corporations. These corporations continuously evaluate the pros and cons of off-shoring key functions and processes, which affect the Swedish NIS.
- R&D as an important characteristic for private sector competitiveness. Sweden has among the highest R&D intensities in the world and an NIS similar to the Swedish probably will meet the same global challenges and opportunities.

Our short list of countries which fit this list consists of:

Finland, which is small, has an industry structure similar to Sweden's as well as a high tax rate (although less than Sweden's), high R&D levels in both private and public organizations

Denmark, which is small and has a high tax rate, higher than Sweden's

Germany, albeit a large country, one of Sweden's largest trading partners, imports as well as exports, frequently competes in the same markets

United Kingdom, also a large country, but (like Germany) one of Sweden's largest trading partners, with a well-developed service sector

Netherland, with its large company profile and a size which make it interesting to compare with[4]

[2] Perhaps the loss of export market for Finland when the Soviet Union fell apart can be considered as an example of an exogenous chock demanding a complete rethinking of large part of the NIS constituents.
[3] This follows the argument in the matching on observables discussion in quantitative evaluation.
[4] Netherlands large transit trade complicates the comparison however.

Switzerland, small country with high R&D levels, dependent on large corporations

Austria, small country with high research and innovation policy ambitions

These countries are often close to Sweden on many scoreboards presented on growth and innovation. They are, however, of special interest not just for their performance in, for example, the European Innovation Scoreboard but for the structural characteristics mentioned above, which we believe is important to consider when framing and assessing the performance of the Swedish NIS. [5]

These countries face similar global challenges in a world where trade has increased in volume and where the ICT development has fostered an internationalization of supply chains, developments which have, in turn, have created a "trade-investment-services nexus" at the heart of so much of today's international business."[6] Interestingly, according to an OECD-report, the selected group of countries is the ones which has been partly sheltered from the first wave of globalization, but is increasingly more exposed to globalization and increasing competition in research and innovation from emerging countries as they acquire more sophisticated means of production.[7]

The increasing interconnectedness of research and innovation has other methodological implications. Analysis of national innovation systems builds on the notion that the performance of the system depends on the element that has the lowest value, and that improvements can be achieved by removing or adjusting the weakest link that constrains the performance of the whole system. Given the assumption that there is a sufficient supply of relevant NIS-related indicators and that we have succeeded in selecting the ones relevant for Sweden, we search and analyze where weak links seem to exist for Sweden.[8]

This review focuses on the time period from 1995 to the present. During the 1980s, many countries changed to more market-friendly policies with less governmental regulation of the economy. Sweden started reforms in this decade, but the crisis in the beginning of 1990s struck Sweden hard and forced policymakers to speed up the reform process.[9] Therefore, we do not consider the early 1990s as a relevant time period for assessing the performance of the Swedish NIS.

Today, there is a relative abundance of statistics and indicators for describing innovation systems. In Sweden, the government recently conducted an extensive compilation and benchmarking project.[10] The present report has narrowed the selected indicators in order to analyze and focus on specific aspects of the NIS.

[5] Lundvall & Borrás (2005) p 614. A region which we believe is relevant for Sweden to compare with and learn from is Ontario, which has a size and business and trade structure similar to Sweden's. Unfortunately, we have not had the time to adjust to the relative unavailability of statistics on Ontario. Note also that even if we identify similarities between these countries, large differences remain. For example, although Denmark and Sweden both have high tax rates, they differ in the means by which the taxes are collected.

[6] Baldwin (2011) describes the development of the nexus in detail.

[7] Rae & Sollie (2007)

[8] See e.g. Acs & Szerb (2010) for a discussion and references regarding the so-called "Theory of the weakest link."

[9] Ejermo & Kander (2009) discuss the suitability of time periods.

[10] Swedish Government (2011a).

1.2 Analyzing small open economies in an global knowledge economy

Two premises have influenced the design of our analysis of the Swedish innovation system. The first concerns the question of how wealthy nations such as Sweden and other open economies can stay rich in a rapidly changing global knowledge economy. The second concerns the data and indicators that exist and can be used for analyzing challenges and opportunities in this knowledge economy, where research and innovation to a high extent is crossing technological, organizational and geographical borders. In addition modern innovation are both technological and non-technological (e.g. new business models or social innovations) where the distinction between the two seems to become increasingly blurred.

The innovative performance of a country will still depend upon the performance of its national innovation system, but it does so in a completely changing international context of knowledge production and organization.[11] During most of the 20th century, knowledge generation and production were made by developed countries. Since the early 1990s, rapid knowledge investments have been taking place in emerging countries.[12] Although these countries are still lagging behind the developed countries, these and other globalization forces are strong enough to challenge established ways of thinking about the goals, direction and governance of research and innovation policy.

In addition, before the financial crisis in 2008, two long term shifts in the ways companies create value and generate productivity were underway. First, production nowadays is, to a great extent, conducted in discrete stages and in specific geographical environments around the globe.[13] Companies, nations and regions tend to specialize around specific stages in global value chains (GVC). Secondly, this development has been driven by the application of ICT tools to manufacturing and services, which has been driving a second shift in value creation. Service innovation and service activities in all sorts of firms have been transformed into formalized, codifiable and computable information-based processes, which have altered how value is created in both services and in manufacturing, blurring the distinction between the two. In this world, "closed innovations systems" are replaced by "open innovation" features such as outsourcing, off shoring, and strategic R&D alliances.[14]

The challenges these different drivers' face raises, we think, important issues how to analyze the performance and prospects of small high-income countries. It also raises questions about the resulting policy choices accompanying the changing logic of value creation; or, which indicators can be used in a world which is highly interconnected? Which frameworks are to be used to define the main problems and challenges?

1.1 Outline of report

The outline of the report is as follows: Chapter 2 depicts the economic performance of Sweden's NIS compared to the reference group of countries. Chapter 3 describes the main public actors of the Swedish research and innovation policy system. In Chapter 4,

[11] Globaliseringsrådet (2009)
[12] UNESCO (2011)
[13] Zysman-Breznitz (2010)
[14] Karlsson, Johanson, Norman (2011)

the strengths and weaknesses of NIS are assessed from an indicator perspective. The following chapters dig deeper into the problems and challenges revealed in Chapter 4. Consequently, Chapter 5 describes and assesses the main goals and policy instruments used in Swedish research and innovation policy. Chapter 6 analyzes the performance of Swedish universities in contributing to innovation. Chapter 7 describes the specialization and renewal capacity of the enterprise sector in the Swedish NIS. Chapter 7 also discusses the changes in and challenges for Swedish industry in value creation from a global value chain perspective. Finally, Chapter 8 summarizes the main conclusions and discusses some avenues for more thorough analyses in assessing future policy challenges and policy choices.

Box 1.1 National Innovation System and Innovation

Innovation

The most common definition of innovation is the one put forward by the OSLO manual. Following Schumpeter, the manual defines "innovation" as the "introduction or implementation of something new with respect to product, process, marketing and organization." The key word "new" applies to the contexts of new to the firm, new to the market and new to the world. While "new to the firm" is focused on the diffusion of novelties which firms *act* upon, the other two concepts imply a degree of radicalness or creative destruction in the innovation process. In the innovation discourse, critics have put forward that the concept of innovation is biased towards palatable and finite "things," which do not easily transfer to the service mode of interaction. Furthermore, the focus on an object "innovation" tends to disguise the agent of change behind the innovation or the entrepreneur, implying a tendency of policies "increasing expenditures" in contrast to policies focused on incentives.

Systems of innovation

The literature on innovation systems is extensive; here, we reiterate characteristics of innovation put forward by Charles Edquist (CE) (e.g. Edquist & Hommen 2008) and Bengt-Åke Lundvall (BÅL) (e.g. 2007). BÅL describes NIS as an approach for study departing from four assumptions:

National systems differ from each other in their specialization of production, trade and knowledge

Parts of the knowledge influencing the economic output are localized and difficult to transfer (tacit knowledge).

Following the second assumption, important elements of knowledge are embodied as relations between individuals, individuals and organizations and as routines or practices.

Essential to innovation processes are relational components like interaction and cooperation. Rather than occurring in isolation, innovation is the result of cumulative learning processes.

These differentiate the NIS perspective from neoclassical economics. BÅL further argues that NIS is a focusing device, not an academic construct. NIS cannot be limited to a new word for the traditional Science & Technology perspective. Rather, learning in the form of step-by-step improvements as well as in the form of radical technological innovations is of importance to economic development. BÅL's guidelines for investigating NIS depart from following claims:

1. Firms (businesses) play the most important role in NIS.

2. Firms innovate while interacting with other firms and "the knowledge infrastructure."

3. Firms' methods for stimulating innovation and learning are reflections of the national institutional setting for education, the labor market, etc.

4. Firms in different sectors contribute in different ways.

BÅL focuses on the "learning" aspect of innovation and underlines the different aspects of learning in activities that Science and Technology (STI) has characterized as "doing, using, and interaction" (DUI). BÅL argues that much of today's focus on STI learning unfortunately neglects these learning aspects of DUI.

Charles Edquist has put forward a more structural view on NIS. According to CE, the NIS has a responsibility to "pursue innovation processes" (Edquist & Hommen 7). The main constituents in the NIS are organizations (not individuals) and institutions (rules of the game). The organizations (firms and public/semi-public bodies) pursue activities which influence the innovation process. Ten key activities identified are (EH 10):

I Provision of knowledge inputs

1. Provision of R&D

2. Competence building through education and training

II Demand-side activities

3. Formation of new product markets

4. Articulation of quality requirements emanating from the demand side with regard to new products

III Provision of NIS constituents 5. Creating and changing of organizations

6. Networking through market and other mechanisms

7. Creating and changing institutions, e.g. patent laws

IV Support services

8. Incubation activities

9. Financing of innovation processes

10 Provision of consultancy services relevant for innovation processes

2 Indicators of the overall performance of the Swedish national innovation system

In this section, we investigate Sweden's overall innovate performance since 1995 based on aggregate productivity and export indicators. Innovation appears to be positively related to productivity at the country level; although there are many other influences as well (Hall 2011) which are not analyzed here. Thus, a measurement the contribution of innovation to overall economic performance must be handled with some care and complemented with other indicators which are done in following chapters. The period in this chapter covers several economic crises, rapid structural change in global trade, and production spurred by rapid technological development, primarily digital techniques.

2.1 Growth in labor productivity

First of all, innovation is about production. Thus, changes in GDP are a natural candidate as an overall measure. The general level of GDP depends, however, on the number of working hours and the utilization of the workforce available, which are factors not directly relevant to the performance of the innovation system. In order to compare GDP levels, it is usually standardized as GDP per capita. This measure underestimates the efficiency of the NIS because it includes both a production concept (GDP) and a population concept, which is affected by a country's demographic structure (e.g., an ageing economy). An alternative per capita measure would be to divide GDP by the working population or the number of people in the labor force. A final alternative would be to use GDP standardized by the total amount of work hours in the economy. We have chosen to follow Bitard, et al. (2008) and Vinnova (2004) and use GDP per hour (labor productivity) as the overall economic output variable for the NIS. GDP per hour gives information about the actual efficiency of the labor utilized, which provides a relevant benchmark to follow and compare how the system actually delivers value.[15]

Diagram 2.1 illustrates these levels for Sweden and the selected comparison countries for the period 1989-2010.

Sweden is tied for fifth place at the beginning of this period and improves to a tie at third place by the end of the period. Switzerland scored lowest in the group for both labor productivity growth and the overall level of labor productivity. As for Sweden, there is a marked deterioration of labor productivity starting in 2006, at which point employment increases for the first time after several years of no growth. Increases in employment with higher economic activity correlates with lower marginal productivity and this fact applies to the German data. For Sweden, increased employment after 2006 correlates with the decrease, which might be connected to the development of unit labor cost where Sweden had much higher growth compared to Germany.

The 1989 to 2010 time period in diagram 2.1 covers four international economic crises (the real rate of interest crisis in the early 1990s, the Asian financial crisis in 1997, the

[15] GDP per hour is, of course, a gross value in the meaning that the attribution from capital or natural resources as well as innovative contributions are included. Thus, different GDP levels and changes of GDP per hour can be explained by factors other than "innovation."

dotcom crisis in 2001, and finally the 2008 financial crisis due to, among other things, defaults in the subprime markets in the US) and large dynamic changes stemming from increased international trade and the diffusion of applications of digital technology. As Sweden made large institutional changes due to the crisis in the early1990s (Box 2.1), it is of special interest to see how Sweden performed excluding those years.

Box 2.1 Some major institutional changes in Sweden in the 1990s and the 2000s

1990s

SEK changed from fixed to floating in November 1992, immediately resulting in a 16 percent decrease in value. Later, the SEK continues as a floating currency with further decreases in value but approaches a more stable level around 2005, fluctuating around the EURO with 1 Euro equivalent to approx. SEK 9.20. (At present the rate is EUR 1=SEK 9.10.)

Deregulation of currency trade and the opening of Swedish stocks to non-Swedish ownership (1992)

Lower taxes in a new tax system with a broadened tax base (1995)

New pension system based on the individual's lifetime earnings is introduced

Establishment of an independent central bank (1997)

Introduction of budget ceiling and surplus target in the state budget

Deregulation of several internal markets: taxis, domestic air carriers, railroad services, telecommunications, electricity suppliers

Sweden joined the EU in 1995 but not the Eurozone.

2000s[16]

Reorganization of the public R&D financing, separate academic R&D councils are merged into present structure (Box 3.2)

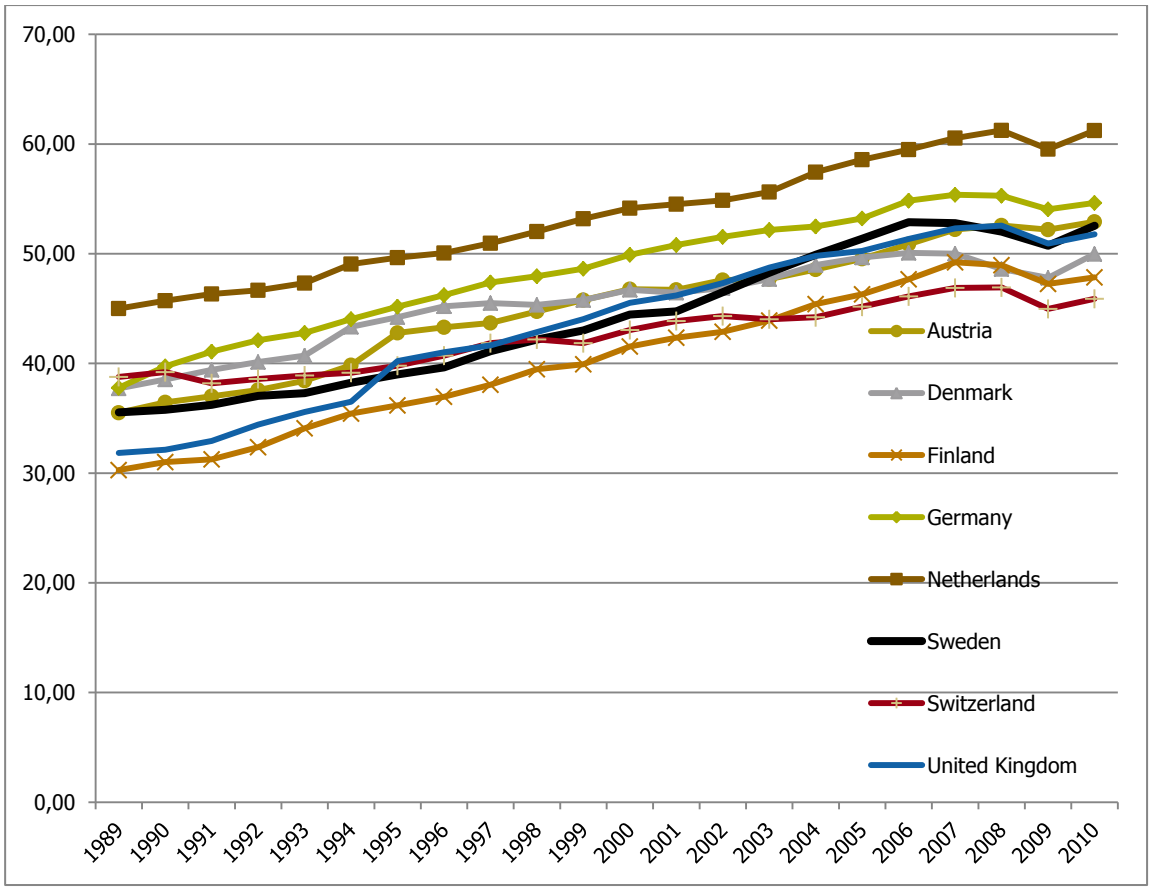
Reform of legislation regarding closed companies in order to spur entrepreneurship (2005)

Introduction of choice-based social welfare services, which implies a further widening of the publicly financed health and social care services market for entrepreneurship (2008 and 2009)

Thus, diagram 2.2 shows that Sweden and Finland have the highest average growth in labor productivity in the "middle period" 1995-2007, suggesting a capability to adjust rapidly to new economic conditions. Part of Sweden's performance is partly attributed to the exit of low-productivity enterprises due to the deep crisis in the beginning of the decade. The decision to let the currency float also spurred exports, leading to less relative unit costs.

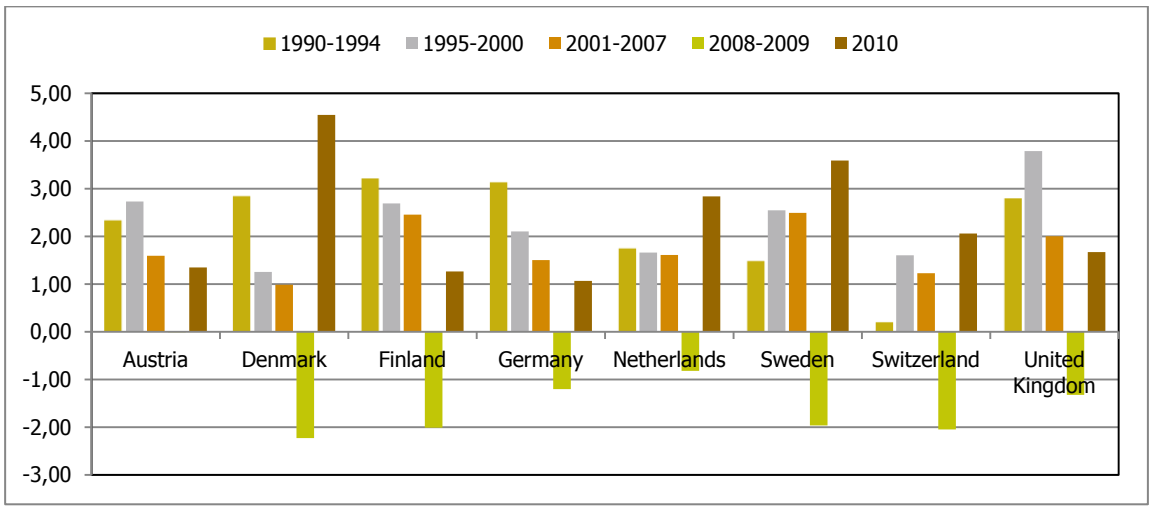
[16] The present organization of the "direct" research and innovation policies is more or less the same since 2005. See Inno Policy Trendchart (2007) for a thorough discussion of this.

Diagram 2.1 GDP per hour in 2010 price levels PPP according to EKS method



Source: "The Conference Board Total Economy Database, January 2011, http://www.conference-board.org/data/economydatabase/"

Diagram 2.2 Average growth in GDP per hour in different time periods, 2010 price levels, PPP according to EKS method



Source: "The Conference Board Total Economy Database, January 2011, http://www.conference-board.org/data/economydatabase/"

2.2 Growth in total factor productivity

Total factor productivity (TFP), or multifactor productivity, measures a country's economic growth net of qualitative and quantitative changes in labor and capital, and including activities which commonly are presumed to contain innovative content.[17]

In Diagram 2.3, the period 1990-2009 is divided into four periods. During the first period, 1990-1994, Sweden suffers from the crisis in the banking sector, general rises in costs and the real rate of interest crisis common throughout Europe with low aggregate demand, partly spurred by the German unification process. Together with Switzerland, Sweden's TFP rates were the lowest in this period although on par with Austria, Germany and the UK. Finland excels in TFP growth rates during this period.

In the following period, which starts with the dot.com crisis in 2001, Finland and Sweden suffer especially hard. Both countries regain growth later and, on the whole, Finland and Sweden have the highest TFP growth rates between 2001 and 2007. Diagram 2.3 also shows that the Swedish TFP performance in 2001-2007 is second only to Finland's. Denmark's TFP rate is noteworthy in its lack of performance since 1995. The main explanation to this is probably that the growth in global demand has not favored the Denmark's industry specializations (e.g., food and agriculture).

Diagram 2.3. Development in TFP for Sweden and comparison group of seven countries, 1990 to 2010.

Source: Total economy database, Conference Board

In summary, Sweden has gained in ranking when measured in GDP per hour. More importantly, Sweden's large TFP growth over the last ten years suggests a high level of innovative activity. Noteworthy is Denmark's lack of performance since 1995 as well as the modest development in Switzerland with respect to both TFP and labor productivity. Various studies have found correlations with high TFP in Sweden and high investments in IT-capital and likewise with investment in "intangible" capital (see further section

[17] TFP emanates from the growth accounting literature and is derived as a residual or production net of changes in labour and capital. TFP includes improvement in production efficiency, effects from unmeasured output, input (e.g., intangible capital) and measurement errors. See Conference Board (2011) for definition of the TFP and Van Ark & Hulten (2007) for an discussion of the measurement of innovation.

7.2.2). Further, an important driver of the growth in Swedish economy has been the telecommunications industry which has shown high productivity growth.

2.3 Innovation in export statistics

In a report to the Swedish Government, the Swedish Agency for Growth Policy Analysis investigated the structure of competitiveness based on export statistics between 1997 and 2005 by the means of unit cost analysis (Tillväxtanalys 2009). This approach may also be used for assessing the aggregate contribution of innovation to overall national performance.

The study compared product code levels (i.e. price per kilo) for almost 7,000 Swedish export products with similar imported products' price per kilo from other OECD countries. Products were categorized in three groups: i) Swedish product prices were 30 percent or higher than comparable OECD product prices, ii) Swedish prices were approximately equivalent to the OECD product prices and iii) Swedish prices were less than 30 percent of the OECD product prices.[18]

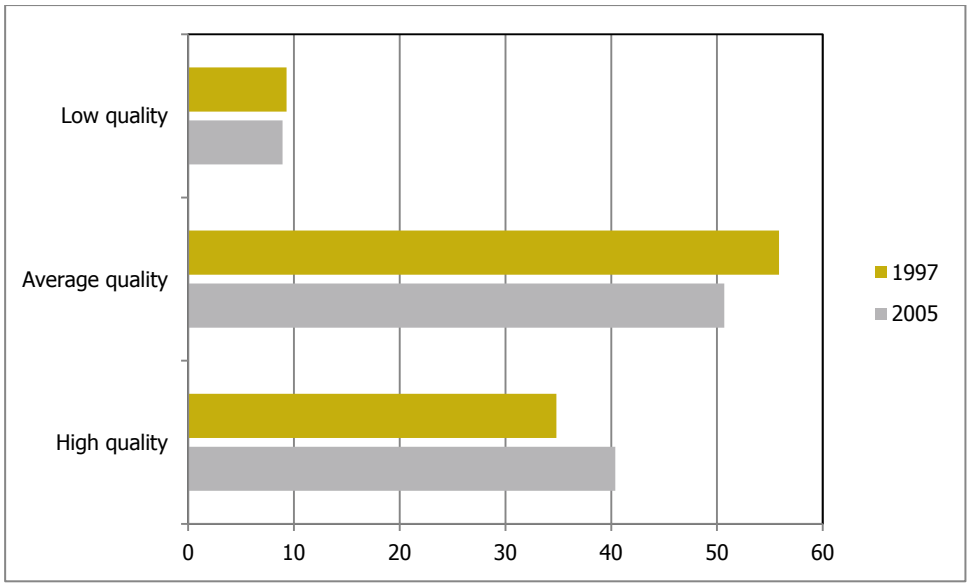
The first group (i.e., Swedish products were priced 30 percent higher than similar OECD products) indicates "high quality" in the sense that despite product similarities, the Swedish enterprises were able to charge a higher price, which can be interpreted as a sign of the product being of a higher quality. (It is this difference in the perception of quality that allows Volvo to charge a higher price than Skoda for their models in the medium-class of cars.) In this group, it is possible to gain export revenues by increasing quality but not necessarily quantity.

For the second group of products (here denoted "average quality" are those products with similar prices as in other OECD countries), the degree of competition is harder with respect to price. Finally, in the last group (Swedish prices lower than those in other OECD countries, "low quality"), competition in prices dominates competition in quality. Here it is required to increase sold quantities in order to maintain export revenues or increase production efficiency more than price cuts.

The core results are displayed in Diagram 2.4. As much as 40 percent of the Swedish export value in 2005 emanates from "high quality" products. This figure is the result of continued growth since 1997, during which time the share of high quality goods has increased from 35 percent, suggesting improved, innovative performance in Swedish industry. A decomposition of the "high quality" proportion of 2005 shows that as much as 30 percent units (of the 40 percent above) of the export value of 2005 was for products categorized as "high quality" in 1997. The number of products categorized as "high quality" in 2005 was 1,542, or 43 percent of all products. This increased the proportion of high quality exports relative to total exports and amounted to 22 percent of the total number of products exported from Sweden. The export analysis is evidence for Sweden's success in selling "high quality" products to a larger extent between 1997 and 2005.

[18] The relationship resembles the conventional Revealed Comparative Advantage indicator (see chapter 7), but instead of export share, price per kilo is compared. The method is not suitable for aggregation on a general product level as too-heterogeneous products will skew the analysis. Note that export statistics builds on gross values which disguise the value added in a specific country.

Diagram 2.4 Distribution of Swedish export revenues with respect to ”quality” categories, 1997 and 2005, percent



Source Tillväxtanalys (2009)

2.4 Conclusion regarding overall performance

The findings in this chapter suggest that since 1995, Sweden (and Finland) has been successful in comparison to the selected group of countries. In the area of increased globalization, Sweden’s NIS has increased productivity in terms of both higher labor productivity and higher total factor productivity (TFP) compared to the peer group of countries used in this report. The TFP indicator thus points to a high degree of innovativeness for Sweden. Evidence of Sweden’s success according to an increase in “high product quality” in exports corroborates this picture.

In the following chapters, some of the factors, drivers and constraints behind these figures of the innovative performance of the Swedish NIS will be analyzed on a more disaggregated level. Before doing this in more detail, a description of the public institutional profile of the Swedish NIS is given in the next chapter.

3 Public actors in Sweden's National Innovation System

This chapter outlines the main public actors of the NIS at the national level. Chapters 5 and 6 go more in depth in certain issues in Swedish research and innovation policy development thorough the last 10 years. The structure, role and development of private business in the NIS will be analyzed and assessed in Chapter 7.

3.1 Outline of public activities in the Swedish NIS

Numerous public policies affect the structure conduct and performance of the NIS. In principle, any policy influencing an individual's or an organization's motivation to participate in any kind of economic transaction can be called a NIS policy. In principle, it can be said that all countries have an NIS policy or "Innovation policy," but it can be more or less implicit and fragmented or explicit and strategic with regard to innovation.

The government in Sweden is organized in ministries, which are, by international standards, quite small. As is common elsewhere, the Ministry of Finance governs the most important structure governing entrepreneurial inducements: taxes. This ministry focuses mainly on policy from a macro-economic perspective. Innovation is something which derives from macro-economic stability, sound public affairs and efficient competition legislation.[19]

In Sweden, the manifestation of the concept of innovation at a policy level started with the creation of *the Swedish Agency for Innovation system* or *Vinnova* as a result of the large re-organization of public R&D financiers in 2001. The creation of Vinnova can be said to be an ambition to have a more strategic policy on Innovation in that the responsibility for the Agency was shared by two ministries, education and enterprise. Another sign of a strategic policy making was the R&D bill launched 2002 with the title "R&D and Collaboration in the Innovations system". Finally in 2004 the government announced its National Innovation strategy – Innovative Sweden. The strategy prepared the ground for more funding to joint research programs with the industry. However with the change in government in 2006 new priorities was set and the concept of innovation reclined the momentum of being a concept more strategic beyond "direct" R&D and innovation policy.[20]

Innovation policy in Sweden is, therefore, not considered at the general policy level where other policy measures are dealt with. In Sweden, public policy is organized according to the chapters in the annual budget bill, which is the first bill in the parliamentary year, which begins at the end of September. The chapters follow a defined structure in order to increase the opportunities for auditing by Parliament and thus seldom change. Each chapter is an area of public expenditure. Chapter 16, for example, concerns education and university research and covers all kinds of education from

[19] See e.g. OECD (2010) ch 4 on Innovation policy mix for a discussion.
[20] Again see Inno Policy Trendchart (2007) for a thorough discussion of this e.g. p 24. This report presents the innovation policy milieu in Sweden and the most important measures which now need to be assessed.

kindergarten to doctoral research. There is no chapter on "innovation" or "innovation policy."

In Sweden, a "policy area" (politikområde) is a much looser concept and consists of sub-areas of the chapters. These areas are delimited by different ministers' areas of responsibility. The measure taken in order to mobilize responsibility over current chapter and policy areas is to launch "strategies". Things might change though, a service innovation strategy was launched in 2010 and during last year's annual inauguration of the parliament, the government declared that it plans to publish an "innovation strategy" in 2012.

The standard way to narrow down the number of public actors in the NIS is to limit the area of "innovation policy." In Sweden, "research and innovation policy" is a concept which implies a focus on a limited number of public bodies, authorities and organizations as well as the means and measures mandated by these bodies. These implied limitations also apply to the coverage and influence the innovation policy has on the NIS. A relatively small change in public expenditure for research and innovation will be hard to trace at the macro level. The difficulty of tracing such effects implies that the areas where public actions are taken need to be backed up by careful monitoring and thorough analyses and evaluations in order to assure cost-effective interventions. Thus, Vinnova has been asked to produce two impact evaluations of its pursued programs every year (Box 3.2).

Box 3.1 depicts the main public bodies for the Swedish NIS with a focus on research and innovation. The following sub-sections describe some of the characteristics of the main actors.

Public research financers

The research and innovation policy in Sweden is dealt with by primarily two ministries, the Ministry for Education and Research (MER) and the Ministry for Enterprise, Energy and Communications (MEEC). In Table 3.2 below, the governmental outlays on R&D (GBAORD) are exhibited. From the table, we can see that the total GBAORD decreased between 2010 and 2011 by almost SEK 1b to SEK 29b. This change is the result of a decrease in R&D funds from other civilian agencies, like the Traffic Authority, as well as decreased financing for the Swedish Space Board. MER allocates a base funding for research at the universities which amounted to SEK 14b in 2011. An evaluation of the quality of the research plays a role in the process of allocation, but not a decisive one.

The Ministry for Education and Research also finances research through the research councils VR, Formas and FAS. The research councils distribute funds according to competitive principles. The three research councils distributed approximately SEK 5.9b in 2011, primarily to universities.

Box 3.1 Main public actors in the Swedish NIS

A Government (ministry level)

Education & Research (U) http://www.sweden.gov.se/sb/d/2098	Enterprise, Energy & Communications (N) http://www.sweden.gov.se/sb/d/2067/a/20348	Other ministries (Defense, Rural, Environment)

B Governmental agencies financing research

Swedish Research Council, VR (Vetenskapsrådet www.vr.se) General financer, curiosity-driven research, competitive allocation Swedish Research Council Formas, www.formas.se promotes and supports basic research and need-driven research in Environment, Agricultural Sciences and Spatial Planning Swedish Council for Working Life and Social Research, FAS (www.fas.se), finances research in Social Science with focus on labor relations	Energy agency (www.energimyndigheten.se) R&D in needs driven energy topics Swedish Governmental Agency for Innovation Systems, Vinnova (www.vinnova.se) Needs-driven research in several areas excluding energy Swedish Space Board Swedish Transport Administration, Trafikverket (www.trafikverket.se)	Swedish Defense Material Administration, FMV (www.fmv.se)

C Independent but public foundations with a R&D financing mission (U)

Strategiska (www.stratresearch.se) SSF KK-stiftelsen (www.kks.se) Mistra (www.mistra.org) Health areas Vårdal (www.vardal.se)	Research exchange STINT (www.stint.se) Intl Institute for Industrial Environmental Economics IIIEE (www.iiiee.lu.se)

D Higher education agencies (U)

Responsible for evaluating higher education and higher education statistics HSV (www.hsv.se) VHS (www.vhs.se) responsible for applications CSN (www.csn.se) Responsible for student loans	Internationella programkontoret (International Education Exchange Programs) www.programkontoret.se

E Higher education & public R&D performers; universities (U)

Higher education at 28 locations, 3 cycles 24 location, 2 cycles 2 locations, single topic (cycles refers to the Bologna nomenclature)	Largest R&D performance with 57% of all R&D expenditure at universities Karolinska Med Univ Lund Univ, Uppsala Univ, Göteborg Univ, Stockholm Univ

F Public and semi-public research institutes (N) www.ri.se

SWEREA (www.swerea.se) SICT (www.sict.se) STFI-Packforsk (www.stfipackforsk.se) SP (www.sp.se)	FOI (www.foi.se) Swedish Defense Research Agency VTI (www.vti.se) Road & transport research

G Agencies and organizations supporting innovation (N)

Vinnova (www.vinnova.se) Energimyndigheten (www.energimyndigheten.se)	Tillväxtverket (www.tillvaxtverket.se) PRV (Patent Authority, www.prv.se)

H Public foundations and state-owned enterprises with a mission to provide financial and non-financial support to SME and early stages ventures (N)

Industrifonden (www.industrifonden.se) Almi (www.almi.se)	Innovationsbron (www.innovationsbron.se Incubators (www.sisp.se) (private organization)

Note: As for 2011 Remark (U) and (N) denotes under which ministry the organization agency belongs to

Academic research is also financed by the independent foundations. In the mid-1990s, the government created several independent research foundations. This financing is limited to certain areas of interest and is not as general as the financing from the research councils. Together, these foundations distributed SEK 1.2b in 2011.[21]

Table 3.1 Government budget outlays on R&D (GBAORD) in Sweden, SEK millions, 2011 prices

	2008	2009	2010	2011
Total financing from government	25 960	28 669	29 887	28 974
Universities	11 685	13 457	13 829	14 110
R&D financing agencies and research councils (excl defense)	6 562	7 217	7 803	7 878
Defense related R&D	3 136	2 389	2 209	2 223
Other civilian agencies	4 577	5 596	6 036	4 753
International organizations	0	10	10	10
R&D financing agencies and research councils				
Vr	3 644	4 086	4 564	4 608
Fas	347	399	399	398
Formas	734	860	908	904
Vinnova	1 837	1 872	1 932	1 968
Semi-public R&D financing foundations (not included in sum above)				
Total	1 187	1 289	1 280	1 209
SSF (Strategic Research Foundation)	458	510	563	569
KK (Knowledge Foundation)	127	192	173	214
Mistra	172	232	216	168
Vårdal	65	41	37	33
Östersjö	293	266	236	176
STINT	57	37	44	38
IIIEE /www.iiiee.lu.se	15	11	11	11

Source: Statistics Sweden (2011) series UF17, own calculation
NOTE: Not included in this table are the Municipal councils' financing of research, primarily in health areas, for a sum of approx. SEK 1.5b

The Ministry of Enterprise, Energy and Communications channels funding to research based on identified targets. The financing of this research demands, in general, strong partnerships between private and public research providers in order to enhance potential commercialization aspects. The main financing agencies are the Agency for Innovation Systems (Vinnova) and the Swedish Energy Agency.

From 2008 to 2010, Vinnova's annual financial support for R&D was approx. SEK 2.1b. The largest part of Vinnova's funds have been given to different programs for enhancing

[21] Strategic Research Foundation (SSF) finances strategic research centers and individual researchers through grants with a focus on biology and life sciences, systems and communication technology, materials development, process and product development technology and KK Foundation finance research performed in the "new" universities and the regional university colleges. KK supports the specialization of the profiles of new universities. MISTRA focuses on research on sustainable living conditions. The Vårdal foundation finances research in public health and nursing. The STINT foundation provides fellowships for (postdoctoral) education in Sweden in International Relations. The IIIEE is both a financing body and research organization focused on environmental economics.

the interface between academia and research in advanced areas of different business sectors like materials, transport and IT. These sector programs were initiated as an outcome of the Innovation Strategy of 2004 and will be terminated in 2012.

The Swedish Energy Agency funds support for sustainable energy research in 2009 and amounted to approx. SEK 1.2b.

In 2011, approx. SEK 2.2b was allocated to R&D for defense-related projects.[22] Defense-related R&D is primarily channeled through two defense related agencies, the Defense Material Authority (FMV) and the Swedish Defense Research Agency (FOI). Table 2 above indicates decreases in defense-related R&D since 2008. Finally, civilian agencies like Trafikverket (the Swedish Transit Administration), the Swedish National Space Board and the Swedish Environmental Protection Agency also provide financial support for R&D within their areas.

Universities

In Sweden, universities and large private-sector corporations are the main actors in R&D. Among more than 50 universities and university-colleges exists in Sweden, only a few—the oldest and largest—do R&D on a large scale. Five universities (Karolinska Institutet, Lund, Uppsala, Göteborg, and Stockholm) dominate university research with almost 60 percent of R&D funds being allocated to these institutions.

The quality of education on both undergraduate and graduate levels is evaluated continuously by the agency Swedish National Agency for Higher Education (HSV). The allocation of research financing is increasingly determined by competitive principles, like publications and citations.

Innovation intermediaries

The innovation intermediaries (or bridging institutions) consist of the actors under the last three panels in Diagram 3.1. There are two main types of actors. One is the public and semi-public research institutes the second are the agencies and organizations that work with bridging discoveries to commercialized ventures.

There are two main kinds of research institute in Sweden, both of which differ from research institutes on the European continent. First, there are research institutes which are more or less governmental agencies, but with permission to charge for services performed, including, for example, the Swedish Defense Research Agency (FOI) and VTI, which focuses on transport analysis and transport system construction. These agencies' main customers are the Defense and Transport Authorities. The second kind of research institutes is those concerning industrial research and which are more relevant from an innovative system point of view.

The Swedish Industrial Research Institutes' main mission is to provide for R&D services for the Swedish business sector. In principle, the model is that the private sector businesses buy R&D services from the Institutes, while the state funds an ordinance covering their facilities and skills development. The research institutes' work is to a high extent demand-driven and acts as an interface between academic research and product development in the business sector.

[22] Statistics Sweden (2011) p30

Suggestions have been put forward that the research institutes need to play a larger role and require a larger budget to fulfill this function in the NIS. The industrial institutes were therefore recently re-organized into a four groups: One is *Innventia* (former STFiPackforsk), with a focus on R&D related to pulp, paper, graphic media, packaging and biorefining. The second and third groups consists of several institutes that was merged together under the two larger ones, *Swerea* which focus on R&D in process and production technology while *SICT* consists of institutes related to ICT research. The fourth part of the research institutes consists of the *SP*-group which focus on standards and material technology. The goal of the merger was primarily to gain synergy in size and increase the opportunity to adapt to changes. The state ownership in the research institutes is managed by the public holding company Rise Holding (www.ri.se). Today SP is owned with 100 percent, SICT 60, Swerea 47, Innventia 27 per cent respectively. In total, the research institute sector was allocated SEK 3.3b, or 3 percent of total public R&D expenditures in 2009 (current prices).

The second type of public innovations facilitators is the actors who facilitate bridge-building between discoveries and their commercialization. The Swedish Agency for Economic and Regional Growth (Tillväxtverket) is in charge of the internet portal *Verksamt.se,* which supplies support for start-ups in many areas. The Swedish Agency for Economic and Regional Growth is also a financial provider for businesses via regional funds and product development programs.

Besides funding needs-driven research, Vinnova also supports SME initiating R&D strategies in its "Research and Grow" (“Forska och Väx”) program. Vinnova assists researchers in commercializing their discoveries in their "Key players" (“Nyckelaktörs”) and "Venture Authentication" (“Vinn-verifiering”) programs. The agency also supports innovative clusters through its "Discovery Growth" (“Vinnväxt”) program. Vinnova also provides financial means to business incubators via the bridging financer Innovationsbron, a state-owned company, which also invests in venture equities.

The main public financers of start-ups and SME in Sweden are, besides Innovationsbron, the foundation Industrifonden and Almi (a recent proposal by the government is to merge Almi and Innovationsbron). Industrifonden manages a capital base of SEK 3b and is required to adjust its rate of return to a level that just maintains its capital in real terms. Since the early 1980s, Industrifonden has had the mission of smoothing the supply of venture capital throughout the business cycle with direct and fund-in-fund investments in ventures at both the early stages and at expansion stages.

The publicly-owned company Almi, with a capital base of more than SEK 5b, acts like a bank, supplying SME with loans under the condition that the firm also can attract other creditors or equity investors. The facilitators named above are the principle actors focusing on early stage seed financing.

A final important organizational public structure in Sweden is the more than 30 incubators located all over the country, most often located in Technology Parks and

close to Universities. Innovationsbron is in charge of financial support for a subset of these and works at the moment with the third generation "incubator program".[23]

In summary, the chapter has listed the main public actors responsible for implementing government research and innovation policy ambitions in the Swedish NIS. Thus, the public actor landscape consists of quite a few different actors. In chapter 5 and 6 a more thorough analysis and assessment of some problematic aspects of Swedish research and innovation policy will be discussed focusing on the role and performance of universities in innovation and the governance of policy. But before doing this the next chapter turns to an aggregate assessment of the strength and weaknesses of the Swedish NIS in a comparative perspective.

Box 3.2 List of Vinnova impact evaluations

1. Effekterna av Vinnovas föregångares stöd till behovsmotiverad forskning. Fyra effektanalyser under perioden 1975-2000 (The impact of needs-driven research: Four studies 1975 – 2000; 2002).

2. Impact of the Swedish Competence Centres Programmes 1995-2003 (2004).

3. Effektanalys av nackskadeforskningen vid Chalmers (Impact analysis of neck injury research at Chalmers University of Technology, 2004).

4. Användardriven utveckling av IT i arbetslivet. Effektvärdering av tjugo års forskning och utveckling kring arbetslivets användning av IT (User-driven development of ICT. An impact analysis of 20 years of R&D concerning the use of ICT in work organization, 2007).

5. Effekter av den svenska trafikksikkerhetsforskningen 1971-2004 (Impacts of Swedish traffic safety research 1971-2004, 2007).

6. Effektanalys av 'offentlig såddfinansiering' 1994-2004. (Impact analysis of public seed financing 1994-2004, 2008).

7. The GSM Story (2008).

8. Impacts of the Framework Program in Sweden (2008).

9. Effekter av statligt stöd till fordonsforskning – Betydelsen av forskning och förnyelse för den svenska fordonsindustrins konkurrenskraft (Impact of public support for vehicle research – The importance of research and renewal for the competitiveness of the Swedish car and truck industry, 2009).

10. Analysis of Chain-linked Effects of Public Policy – Effects on Research and Industry in Swedish Life Sciences within Innovative Food and Medical Technology (2009).

11. Investering i hälsa. Hälsoekonomiska effekter av forskning inom medicinsk teknik och livsmedel (Investments in health. Health economic effects of research in medical technology and food production; 2009).

12 Effects of Vinnova's programs on small and medium sized enterprises (2010).

13 Impact analysis of support for strategic development areas in the Swedish manufacturing industry (2010)

14 Effekter av starka forsknings- och innovationssystem (2011) (Impacts of strong research and innovations system).

15. Effekter av forskningsprogram inom material från förnyelsebara råvaror (2011) (Impacts of research in renewable raw materials).

Reports available at www.vinnova.se

[23] An international evaluation of the first generation of the incubator program was commissioned by Vinnova and Innovationsbron in 2009.

4 Assessment of strengths and weakness of the Swedish NIS– a comparative perspective

The analysis in chapter 2 pointed to an impressing innovative performance of Sweden measured by aggregate productivity indicators. In the present chapter a more thorough assessment on some aspects of the strengths and weaknesses of the Swedish NIS will be conducted using an alternative set of indicators. The purpose is to use these indicators to see where Sweden's strengths and weaknesses lay but also to critically assess the reliability and validity of these indicators when framing the challenges and opportunities for small wealthy economies such as Sweden's and that of other similar countries.

The last years have witnessed a surge in growth indicators regarding inputs, enablers, throughputs, outputs and institutional context.[24] The European Union launched the European Innovation Scoreboard with 29 indicators of innovation in order to spur the member states to monitor and achieve the Lisbon targets. The demand for indicators for system analysis other than the use of national account statistics has created hundreds of indicators and methods to aggregate them into composite indicators. In general, this is a positive development, but in order to act upon the statistics, the validity of each indicator needs to be judged.

The chapter will compare the conduct and performance of Swedish NIS by means of the latest version of the Innovation Union Scoreboard (IUS), published by the European Commission initiative ProInno. IUS has 25 indicators and is thus far more restricted than the Global Competiveness Index with its 113 indicators. The IUS provides a convenient way to compare the performance in various parts of the NIS considered important by innovation research. A second reason for choosing IUS is that this is a relatively new, forward-looking compilation which—being an important part of the EU flagship initiative *Innovation Union* and its EU 2020 strategy—is an initiative Sweden and other EU member states have to comply with.[25]

4.1 Comparing performance

The IUS consist of 25 indicators divided into eight innovation dimensions which can be sorted into three groups:

- Enablers,
- Firm activities,
- Outputs.

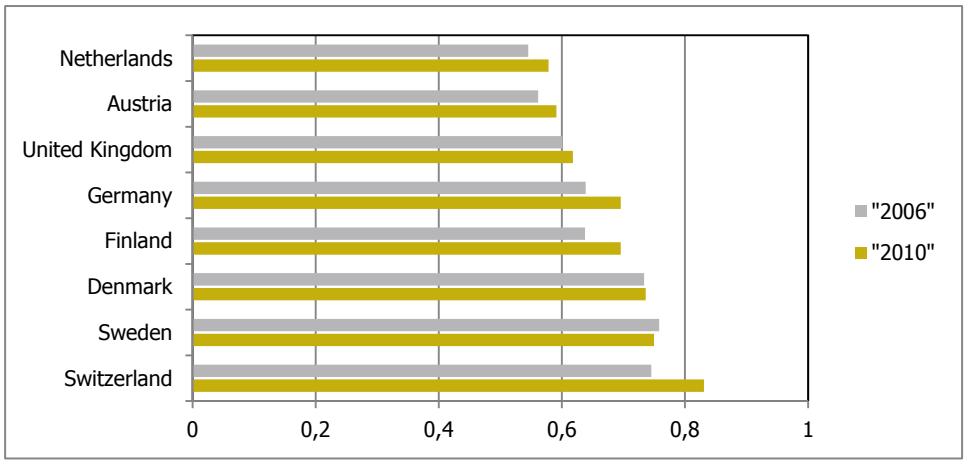
The three groups are also aggregated by the Summary Innovation Index (SSI), which is exhibited in Diagram 4.1 for the reference group of countries for 2006 -2010.[26]

[24] The World Economic Forum has the Global Competitiveness Index. World Bank has the Doing Business index, and Global Entrepreneurship monitors its index. The organization Transparency International focuses on the degree of corruption, among other things.
[25] Swedish Government (2011)
[26] 2010 actually stands for the latest year data is available and not the calendar year 2010. At present, only 24 of the IUS indicators have been computed. The 25th, concerning high growth enterprises, is in process.

According to the composite index, Sweden has, in contrast to its competitors, not improved its value of the Summary Innovation Index. In principle, there may be two types of explanations for this. One is the ongoing convergence of economies, where countries ranked at the top find it more difficult to find room for improvement than competitors approaching from below.[27] The second explanation focuses more on the overall effectiveness of the NIS. ProInno estimates conventional convergence parameters and finds the presence of in-group convergence for the group of countries we focus on in this report (ProInno Metrics 2010).

Rankings are known to exaggerate real differences between countries.[28] In the following, we use the information within the IUS system of indicators to try to find out in what areas Sweden seems to need more attention.

Diagram 4.1 Change in Summary Innovation Index according to Innovation Scoreboard



Source: ProInno Metrics IUS database 2010

Diagrams 4.2 through 4.9 illustrate a disaggregation of the SSI-Index into various sub-composite indices.[29] According to these rankings, Sweden maintains a high rating in five dimensions: *Human resources*, *Finance and support*, *Firm investments*, *Linkages and Entrepreneurships* and *Intellectual assets*. The dynamics since 2006 are mixed. Sweden has declined in two indicators in which other countries have exhibited relative large increases: Switzerland and Germany in *Finance and support* and the UK in *Linkages and Entrepreneurships.* In two indicators, Sweden has a positive development but overshadowed by other countries which have experienced a larger increase: Switzerland, the UK and Denmark in *Human Resources* and Switzerland and Austria in *Intellectual assets*. Finally, in the indicator *Firm investments*, there is less change overall in the various countries. Thus a conclusion is that in indicator areas where Sweden's performance is "best," there are indications of other structurally similar countries "catching up."

[27] Hollanders & Tarantola (2011) p 23

[28] Hollanders & Tarantola (2011) p 22 claim that "…it is not convenient to talk about individual country rankings, but it is better to consider clusters of countries."

[29] A note of caution is due; the analysis rests on data for which the measurements thereof are not exact and perhaps not entirely valid. For these reasons, the implications of the noted differences might be exaggerated. In order to state the relative performance of the Swedish NIS, however, the scoreboard produced by the European Union is a relevant point of departure.[29]

Sweden has decreased its performance in four indicator areas. Two of these areas are mentioned above; the other two are *Innovators (Diagram 4.8)* and *Economic Effects (Diagram 4.9)*. In the case of *Innovators,* Sweden has gained in the rankings despite its decreased value score because Denmark experienced a larger decrease in the value of the index. As for *Economic Effects,* Sweden has decreased in value and gone down in the rankings since 2006. In 2010, however, Sweden will almost tie three other countries with its values for this indicator.

In the dimension *Economic Effects,* Sweden's ranking has dropped from a close fourth to sixth position. In this case, the values are close, but Sweden and the UK experienced decreased values while Finland and Denmark exhibit increases.

In the dimension *Research systems (Diagram 4.3),* Sweden has exhibited an increase in values since 2006 but so have its competitors. The UK and the Netherlands have had a larger relative increase in this dimension, which has resulted in a decrease in Sweden's rank in 2010.

Changing focus from Sweden to the other countries, it is notable that Switzerland ranks highest or top three in all innovation dimensions except *Finance and support* and *Linkages and entrepreneurship*. Note also Germany's low performance in the *Enablers*, mediocre in *Firm activities* but strong in the *Output* group, second only to Switzerland.

This first overview of the various composite indicators suggests that further analysis is needed to determine why Sweden seems to be having difficulties staying ahead. In a first contribution to such an analysis, we look closer at what the statistics behind the dimensions *Innovators, Economic effects* and *Research systems* actually mean and examine whether, given these indices, the conclusions from the composite indicators of the dimensions are still valid.

Diagram 4.2. Human Resources (Enabler)

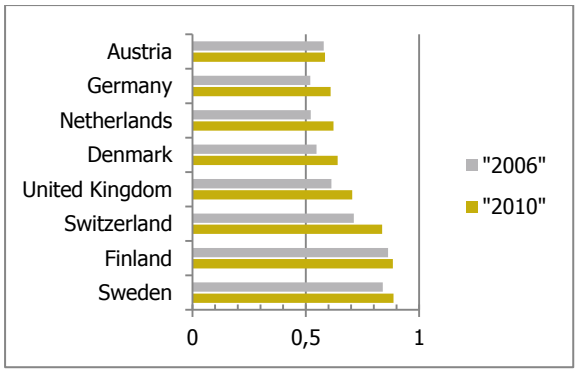


Diagram 4.3 Research Systems (Enabler)

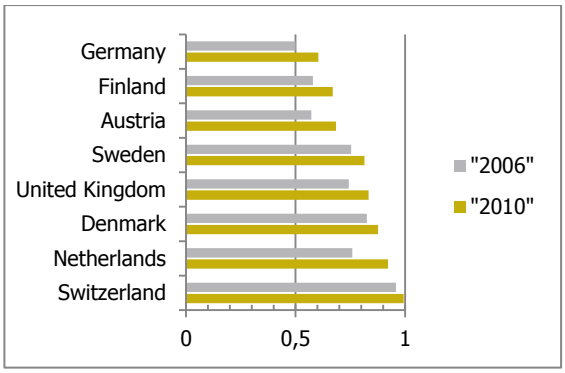


Diagram 4.4 Finance and support (Enabler)

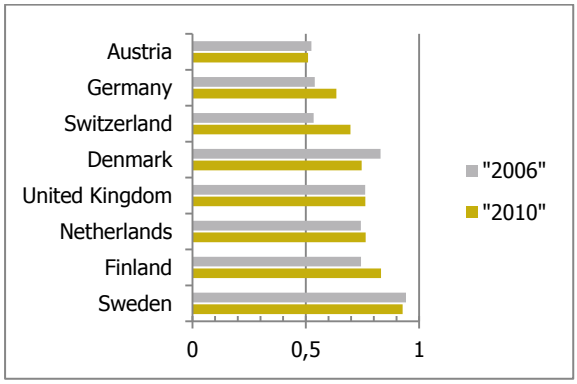


Diagram 4.5 Firm investments (Firm activities)

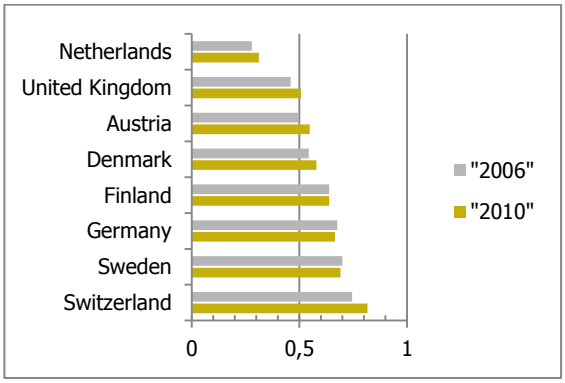


Diagram 4.6 Linkages and Entrepreneurship (Firm activ.)

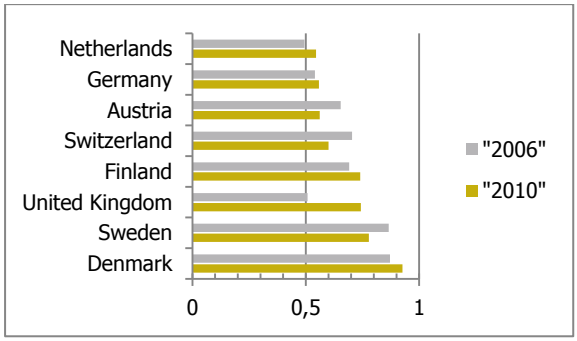


Diagram 4.7 Intellectual assets (Firm activities)

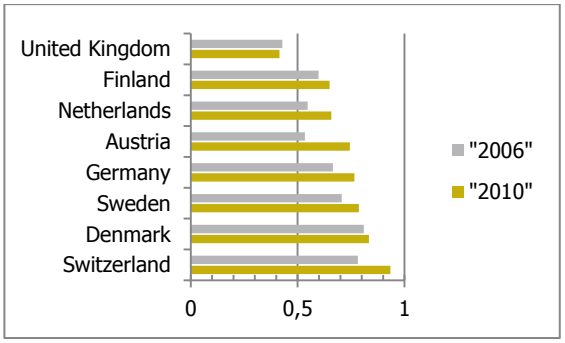


Diagram 4.8 Innovators (Outputs)

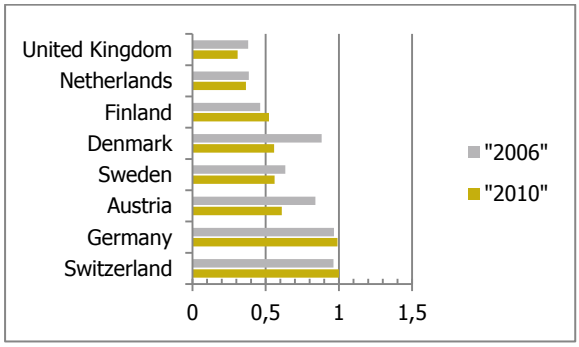
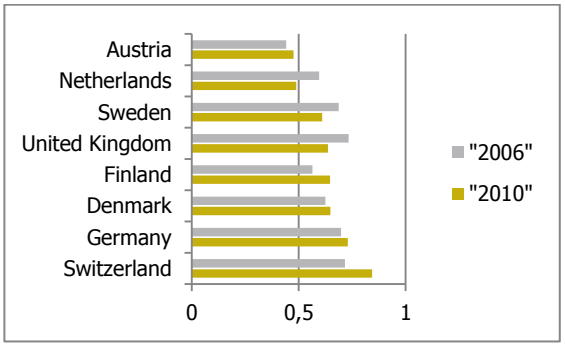


Diagram 4.9 Economic Effects (Outputs)



Source: ProInno Metrics IUS database 2010

4.1.1 What's behind the performance in the two indicators - innovators and economic effects

The two output indicators *Innovators* and *Economic effects* include the following statistical measures:

- SMEs introducing product or process innovations as a percent of SMEs. Data from the Community Innovations Survey (CIS) can be used and for the years 2004, 2006 and 2008 (Innovator).
- SMEs introducing marketing or organizational innovations as a percent of SMEs. Harmonized data from the Community Innovations Survey (CIS) only from 2008, available for some countries 2004 and 2006 (Innovator).
- Employment in knowledge-intensive activities (manufacturing and service) as a percent of workforce. (Data source is Eurostat) (Innovator).
- Sales of new to market and new to firm innovations as a percent of turnover. Data from the Community Innovations Survey (CIS) 2004, 2006, 2008 (Economic effects)
- Knowledge-intensive services exports as a percent of total services exports. Data source is UN and Eurostat (Economic effects)
- Medium and High-tech exports as a percent of total exports according to SITC. Data source is UN Comtrade (Economic effects)
- License and patent revenues from abroad as a percent of GDP where the data source is Eurostat. (Economic effects)

Economic effects

Starting with the economic effects, Diagram 4.10 depicts the sum of sales of "new to the market" and "new to firm" innovations as a percentage of the sum of turnover for all firms for 2004, 2006 (not available for all countries) and 2008. Both the UK and Sweden exhibit large decreases in contrast to other countries' increases. The share of the revenue does not, however, say anything about the size of the revenue. The survey year of 2008 is the year of the financial crisis, and it is a reasonable assumption that this would influence the revenue reported in the survey. But it is not clear how a general decrease in revenue would affect the share of revenues stemming from new products.

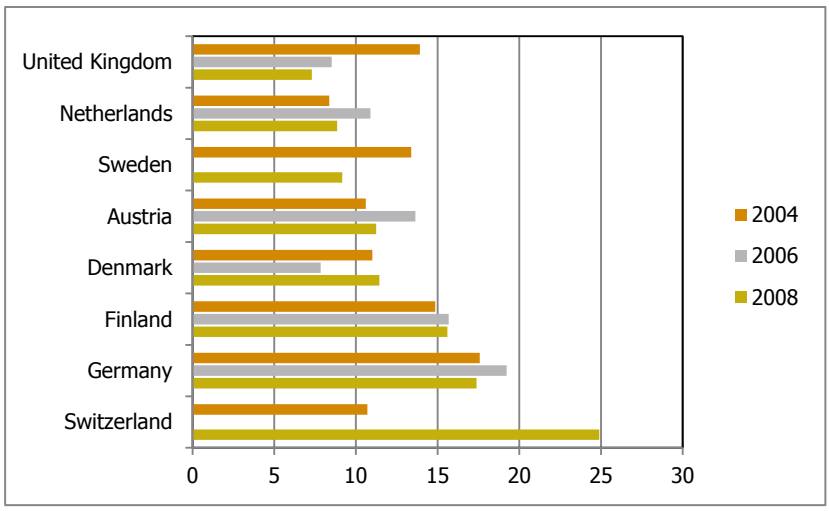
Compared to 2004 data, Switzerland's enterprises seem to have been successful. Austria, Denmark, Finland and Netherlands have also experienced an increase in the share of revenue from new products. Sweden, Germany and the UK, on the other hand, have exhibited a decrease in their share. 2006 data is available for a subset of the countries. Based on this information, the decrease in the UK seems to have started before 2008, while for Austria, Denmark, and Germany the indicator exhibits ups and downs. For example, the point estimate for Denmark is 11 in 2004, 7.8 in 2006 and 11.4 in 2008. Unfortunately, the data from Sweden for 2006 is not available.

The indicator thus contributes to the weak Swedish performance in the dimension. However for 4 out 6 countries where data is available the statistics on this indicator exhibit swings in the estimates which might be an indication of random error in the

survey based estimates. Such random error implies that the differences between countries in point estimates and within countries for consecutive years might not be statistically valid.[30]

The IUS-indicator seems to need more analysis and needs to be combined with other data in order to attain merit. Whether Sweden in fact really has exhibit such a weak performance is thus questionable.

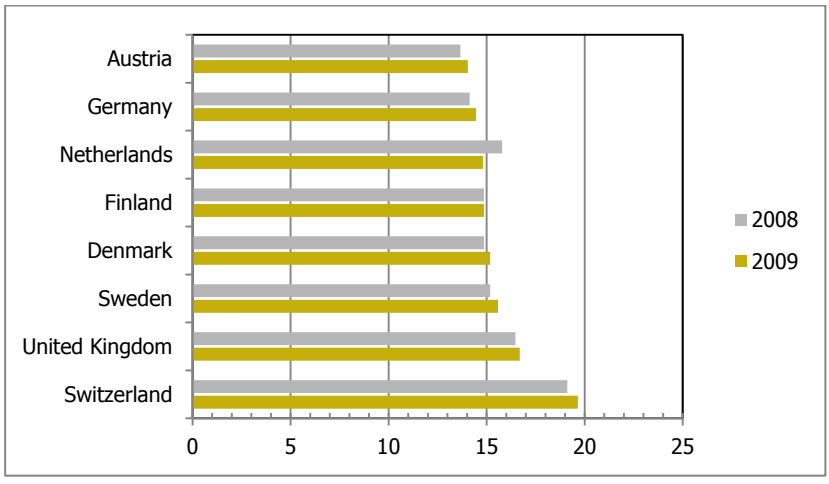
Diagram 4.10 Sales of new to market and new to firm innovations as a percentage of turnover (all firms)



Source: ProInno Metrics IUS database

Next, knowledge-intensive activities are all industries in which at least 33 percent of the employed staff has attained higher education levels. Sweden has increased the value from 15 to 16 percent. Sweden is more or less on the same level as all close competitors except Switzerland (Diagram 4.11).

Diagram 4.11 Employment in knowledge intensive services as a percentage of total employment



Source: ProInno Metrics IUS database 2010

[30] Confidence interval is likely to be around ± 3 percent units

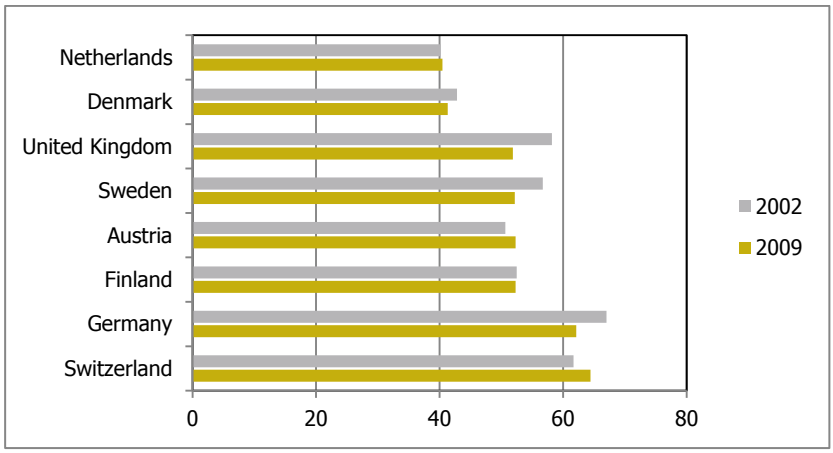
In contrast to the former survey based indicator the indicator of employment in knowledge intensive services exhibits less variation and also a small increase for Sweden. We conclude that this indicator do not contribute to the perceived weak performance in the dimension economic effects.

The third indicator (Diagram 4.12) shows medium and high-tech exports as a percentage of total exports. Sweden is on par with the UK, Finland and Austria both before and after the decrease in the indicator value. The decrease in Sweden and Germany was 5 percent units. United Kingdom has experienced a decrease of 6 percent units.

The categorization of groups as "medium tech" and "high tech" has often been questioned given that there are vast opportunities for specialization and innovation in addition to quite simple assembly, which, in many cases, moves "high-tech" production overseas. Thus, this indicator must be considered of questionable merit in spite of its popularity.[31]An alternative indicator for innovative content in exports was presented in chapter 2. This indicated progress in innovative exports between 1997 and 2005 for Sweden.

We conclude that the indicator medium-tech and high-tech exports as a percentage of total exports also contribute to Sweden weak performance in economic effects.

Diagram 4.12 Medium and high tech product export as a percentage of total product exports



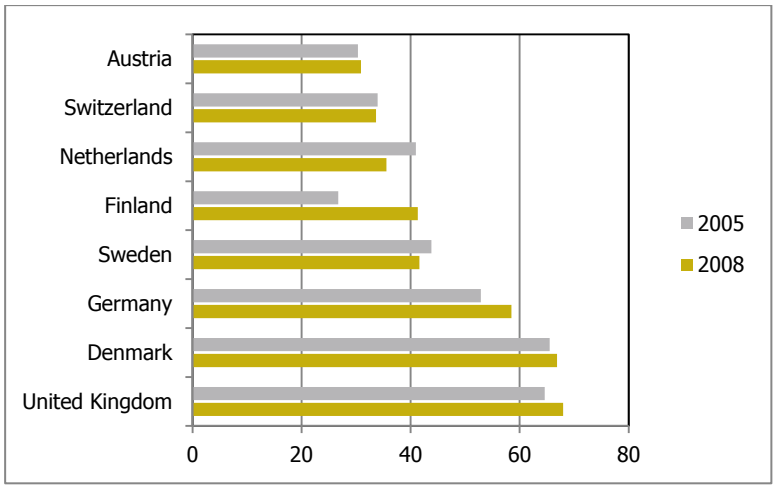
Source: ProInno Metrics IUS database 2010

The fourth indicator (Diagram 4.13), the measurement of knowledge-intensive service exports is an important indicator due to the increasing shift in the division of labor. This indicator is created from statistics according to extended balance of payments services classification (EBOPS). Categories included services are: transports, computer services, insurance, financial, legal, marketing, engineering. Sweden's rank has not changed over the years but a slight decrease is recorded between 2005 and 2008. This result for Sweden is puzzling while other sources tell that Sweden has among OECD countries had the largest increases in services export, and that the kind of services Sweden excel in

[31] Rae and Sollie (2007) show how China according to such export based categorisations is now a leading technology exporter. Xing & Detert (2010) show that one of Chinas high tech export products is Iphones. The value added in for Iphones exported from china is roughly 3 %. In general this is a problem with today's export statistics when international work division disguise the location where "value added" actually is produced.

supplying is primarily computer and information services (see section 7.2.5 Diagram 7.14), which does not seem to show up in this indicator.[32] One explanation might be that the indicator is the net of sales of royalties and licenses an area for which Sweden has had large increases in the period. This area is covered in the indicator "licenses and patent revenues from abroad" (below Diagram 4.14).

Diagram 4.13 Knowledge-intensive services exports as a percentage of total service exports



Source: ProInno Metrics IUS database 2010

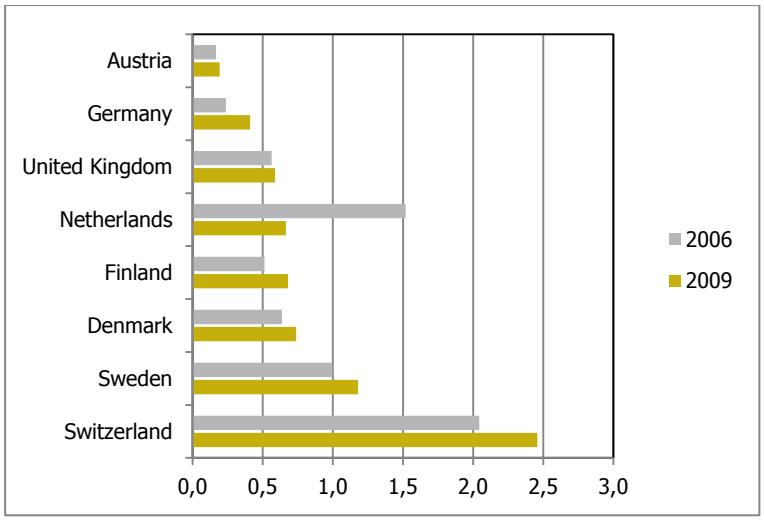
In sum, according to the definition of the indicator knowledge-intensive services (that is the included services in EBOPS) this is the third indicator that adds to perceived Sweden's weak performance in the economic effects dimension.

In the final economic effect indicator the share of export revenue from royalty and licenses transactions is covered. In diagram 4.14 we see that Switzerland could be seen as an outlier with more than twice the proportion of revenues than the other countries in the reference group. Sweden scores high here as well, as expected. A possible reason for the Swiss and Swedish performance might be that the large international corporations in these countries are at the forefront of the "patent businesses," where a large fraction of revenues is trade in patents. The subject of revenues from intellectual assets in this form need more research in order to assess the areas relationship to the NIS. One may note the large drop Netherland experience but which may indicate some kind of measurement problem[33]. Thus, this indicator does not contribute to the Swedish weak performance in economic effects.

[32] SOU (2008) p 90 describes Swedish service export in comparison to EU15 and OECD and p 91 compares with Denmark, Germany and Finland. Denmark is the only country challenging the Swedish experience.

[33] This indicator should perhaps be constructed as a moving average.

Diagram 4.14 License and patent revenues from abroad as a percentage of GDP



Source: ProInno Metrics IUS database 2010

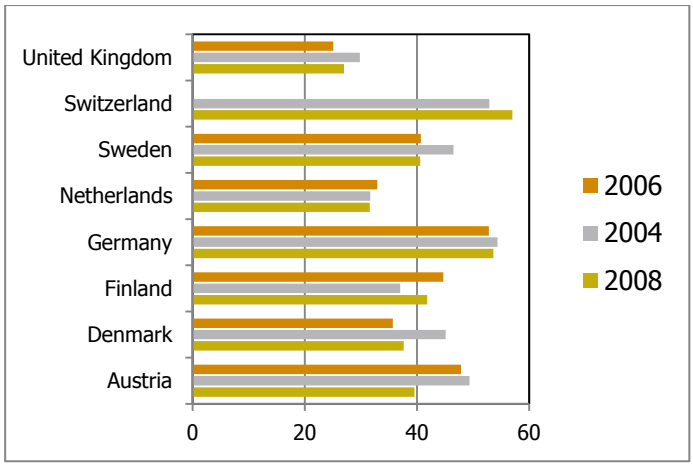
Innovators

The dimension Innovations consists of three background indicators: share of innovators among SMEs, share of SME introducing market or organizational innovation and the share of high growth innovators. Unfortunately this dimension at present suffers from truncated data. The statistics on high growth innovators is not published yet and data on organizational innovation exists only for one year for Sweden.

All countries except Netherland, Switzerland and Finland have experienced lower share of innovative SMEs. Sweden's decrease is less than Denmark's and Austria's respectively (Diagram 4.15). Denmark, Austria and Finland lay within the confidence interval around the Swedish point estimate. Furthermore, the change between years might be within the confidence interval, which casts some doubt on the differences.

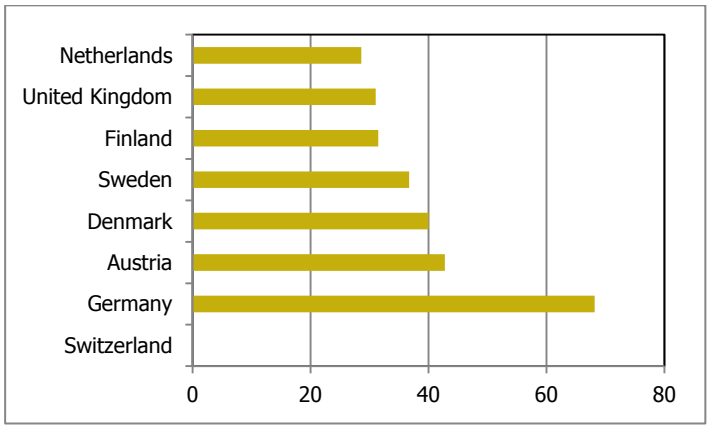
Market and organizational innovation was introduced in the CIS survey measuring the period 2006-2008 (CIS 2008), and Diagram 4.16 depicts the level and rankings for 2008. Before that, the indicator was not measured in Sweden. IUS has imputed the Swedish statistic for 2006 as the same for 2008 and thus derived a non-change between years. In reality we do not know what the figure is for Sweden, thus we do not exhibit any change here. Switzerland does not follow the CIS recommendation in its entirety and has not measured this indicator. Germany has the highest level and ranking according to the indicator. In this dimension the expected 25th indicator on high growth innovative firms will be included, however no data is yet available on this (see also section 7.2.4 and diagram 7.12).

Diagram 4.15 SME introducing product or process innovations as a percentage of all SMEs



Source: ProInno Metrics IUS database 2010

Diagram 4.16 SME introducing market or organizational innovation as a percentage of all SMEs 2008



Source: ProInno Metrics IUS database 2010

In conclusion the decrease in the dimension *Innovators* solely consists of a decrease in the indicator measuring the share of innovative SMEs. But again this is a survey indicator and it seems that the variation in point estimates is quite high both over time and between countries which bring up the question whether the differences can be considered as significant.

4.1.2 What's behind the performance in the indicator covering the R&D area

The other area of concern according to IUS innovations dimensions are the indicators focusing on the Swedish research system. Under the heading "Open, excellent and attractive research systems," this second component of the *Enabler* indicator exhibited an increase for Sweden between 2006 and 2010, but this increase was on par with other countries'.

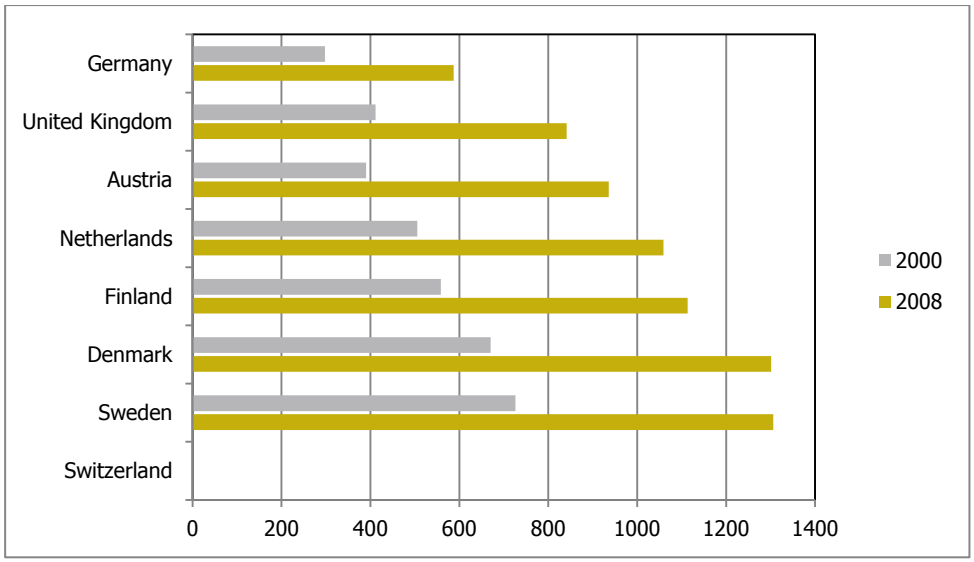
The composite indicator *Research system* is a sum of following statistical indicators:

- International scientific co-publications per million population

  - × The rationale for this indicator is to proxy for the quality of scientific research, as collaboration increases scientific productivity.
- Scientific publications among the top 10 percent most-cited publications worldwide as a percent of total scientific publications of the country
  - × The rationale for this indicator is that highly-cited publications are assumed to be of higher quality.
- Non-EU doctorate students as a percent of all doctorate students
  - × The rationale for this indicator is that non-EU doctorate students reflect the mobility of students as an effective way of diffusing knowledge and attracting high-skilled foreign doctorate students, which will create a net brain gain and will secure a continuous supply of researchers.

Regarding the number of co-publications, Sweden performs best (Diagram 4.17). Note, however, that data is lacking for Switzerland. The figures exhibit a common pattern in that small countries seem to be more efficient in producing scientific results, albeit miniscule in absolute numbers. Denmark, second to Sweden in 2000, was on par with Sweden in 2008.

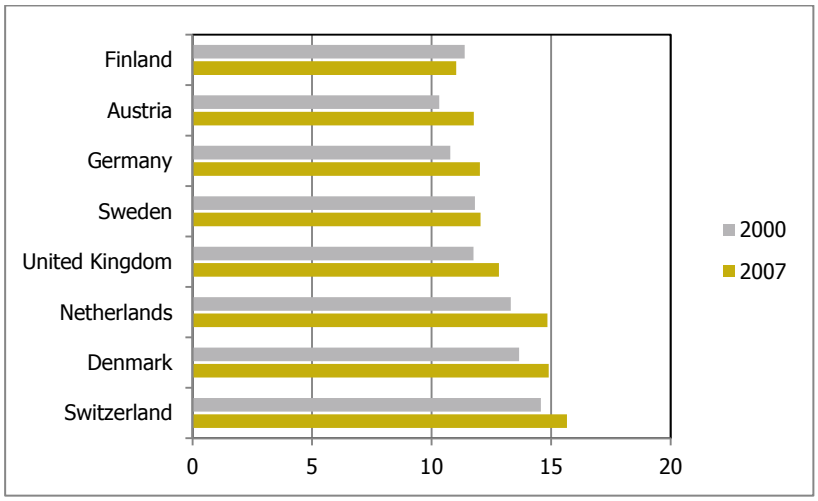
Diagram 4.17 International Scientific co-publications per million population



Source: ProInno Metrics IUS database 2010

Thus, Sweden performs still well in number of publications and co-publications but there are indications of losing ground. The second indicator for R&D system, the share of the 10 per cent most cited publications, is an indicator of the efficiency of the R&D system with respect to quality. As the database focus on contributions written in English one have to consider a negative bias affecting Germany scientific contributions also are made in German. The diagram 4.18 shows that Sweden's high publication intensity does not spill-over in the quality focused measure.

Diagram 4.18 Scientific publications among the 10 percent most cited publications as percentage of total scientific publications in the country, adjusted by field



Source: ProInno Metrics IUS database 2010

Again, Sweden does not differ in relative performance in comparison to Finland, Germany and Austria. The UK, on the other hand, exhibits a higher increase in the 8-year period and, after being on par with the performance of the UK, Sweden is now lagging behind. Switzerland, Denmark and the Netherlands seem to have been fortunate in producing high quality research at a greater frequency than Sweden. [34] The causes behind this will be discussed in Chapter 6.

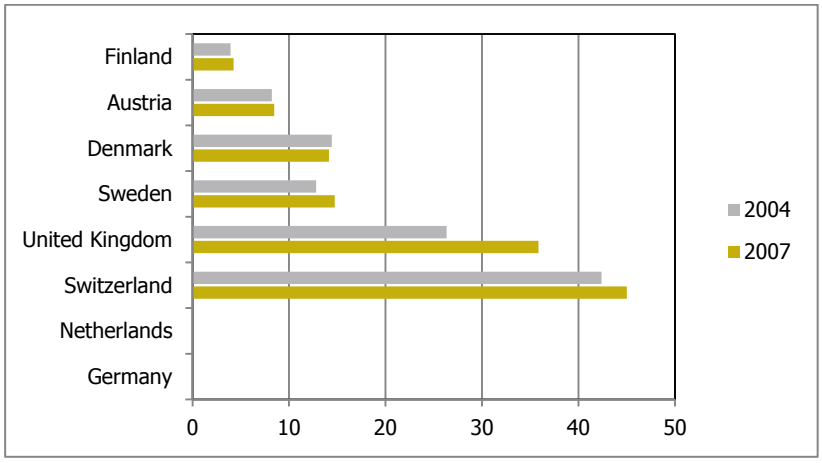
The third and final Research system indicators measure the flow of non-EU doctorate students (Diagram 4.19). This indicator measures how successful a country is in attracting foreign talent. In Switzerland, the indicators measure "non-Swiss" doctorate students, which is a different population and therefore not comparable. The UK attracts more than twice as many foreign doctorate students than Sweden. As a larger and English-speaking country, the UK has an edge in attracting talent. Sweden seems to have improved this figure somewhat between 2004 and 2007. During this time, there was no charge for tuition for students at Swedish universities. This regime has now changed, which has reduced the flow of prospective doctorate students; however, there are no tuition fees charged at the doctoral level of studies. The IUS indicator is based on quite old data; for Sweden, Statistics Sweden estimates that there were 20,080 doctorate students in 2010, of which 5,180, or 26 percent, were not from Sweden. This proportion has steadily increased over the last five years. Unfortunately, the regular official statistics in Sweden do not publish the proportion of non-EU doctorate students, but we can here provide the indicator regarding new doctorate students. In total, 2010 there were 3,470 *new* doctorate students. Among those were 869 from outside EU27 and the Nordic countries (Iceland and Norway not being members). In 2010, therefore,

[34] This pattern is also described in detail by Vetenskapsrådet (2009).

Sweden's share of non-EU (and non-Nordic) doctorate students was 25 percent, with the majority coming from Asia. In 2007, the share was 17 percent.[35]

Again the lack of data for some countries implies that the composite indicator conceals deficient information. We conclude that even if Sweden cannot compete with the attraction of the UK, the knowledge flow measured in foreign doctorate students and non-EU doctorate students signal that Sweden is an attractive country to pursue research in.

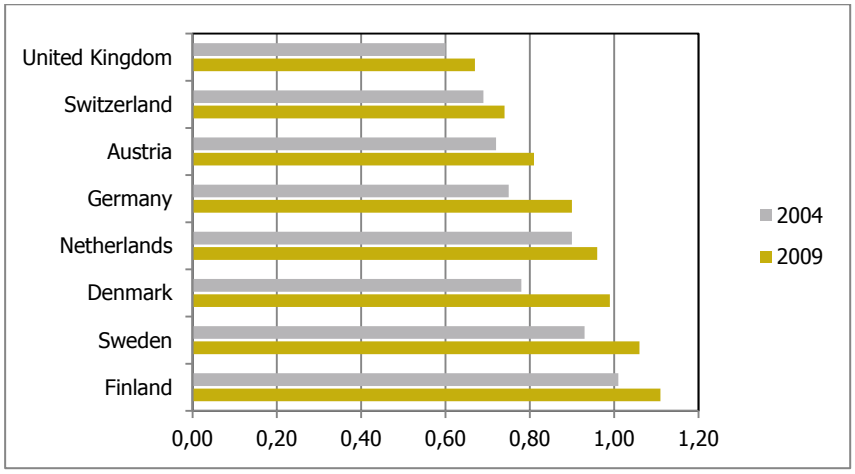
Diagram 4.19 Non-EU doctorate students as percentage of all doctorate students



Source: ProInno Metrics IUS database 2010

Finally in Diagram 4.20 the public expenditure on R&D is shown. Sweden is second to Finland in allocating relative shares to R&D. The increase emanates from the new means allocated to the area in the R&D and Innovation bill of 2008 (which will be described in Chapter 5).

Diagram 4.20 Public expenditure on R&D



Source: ProInno Metrics IUS database 2010

[35] In 2007 the new doctorates totaled 2 810. Of those were 820 or 29 % foreigner and among those 500 was non-EU and non-Nordic (17%). Statistics Sweden (2011b p39f) for statistics on 2010 and (2008) p 51-52 for statistics on 2007.

4.2 Conclusions

Sweden ranks high in a number of innovation league tables and innovation indicators. This evidence of strength of the Swedish NIS has been questioned by critics who claim that Sweden has high values on input but struggles to convert this into innovation economic effects. The evidence of low output put forward has been of three kinds: 1) Low export in high technology goods (Edquist and McKelvey 1991); 2) Poor growth performance (Aspling, Andersson & Henreksson) from 1970 to 2000; and 3) Low innovation intensity (share of new products in sales) according to Innovations surveys in the late 1990s (Bitard, et al.). Bitard, et al. even conjecture, based on CIS data, that Sweden-based MNC was especially poor innovators in a comparative perspective.

In chapter 2 we concluded that from overall economic measures of the performance of the NIS, data do not support such conclusions. In this chapter another set of partial indicators (based on IUS-data) has been used to frame and assess the innovative performance on a more disaggregated level and along several dimensions.

The analysis of the IUS-data seems to add support to the perception that Sweden mainly has an input advantage but lack in efficiency to exploit this in economic output and is partly due to a decrease in the values of following three indicators:

- The share of revenue streams from new to market and new to firm products and processes
- The export revenues from knowledge intensive services
- The revenue share from medium and high tech export

However, there are a number of drawbacks in the reliability and validity of these indicators that cast some doubts on the general conclusion about a deficient output performance. The first indicator exhibits large swings between the years for a number of countries. The third indicator is contradicted by other statistical measures saying that "high quality" Swedish products amount to a large share of total exports. The export share of knowledge intensive services need more research to understand how it is aligned to other indications of successful export in services like computer and information services (which is done in chapter 7).

Regarding the *Innovator* dimension we conclude that this indicator is solely based on *one* statistical measure, the share of SME innovators. This measure is also based on the CIS-survey where random errors can be large. At present we do not know for sure whether the exhibited change over time and between countries really is significant. The reliability in the indicator must thus be investigated more thoroughly and in chapter 7 recent national and international data is used to provide analyze Swedish performance on this dimension.

Finally the dimension *Research systems* suggest that Sweden lags in improvement in the quality of research and again this will analyzed more thorough in chapter 6. We also call for attention the degree of attracting foreign doctorate students. Swedish statistics exhibits an improvement over time but again not in the same size as the UK.

To summarize, we have considered in more detail seven of the IUS indicators in the output group consisting of the innovation dimensions of *innovators* and *economic effects*

where Sweden according to the composite index were found with a weak performance. After a closer look of the statistics behind the composite index, we draw the conclusion that the variation between the selected countries among several statistical indicators is too great to conclude that Sweden has a systematically weaker output than the rest of the countries. It seems that the composite index conceals this kind of uncertainty and therefore must be handled with care when framing the challenges and problems of Sweden's innovative performance. The remaining three chapters will therefore go deeper into some of the various aspects of the findings suggested here.

5 Framework conditions: Some aspects on ambitions and governance of Swedish research and innovation policy

The goals and design of a national research and innovation policy must rest on some notion of how innovation is transformed into economic performance and well-being. This chapter describes some of the main characteristics, tensions and constraints of research and innovation policy during the last decade, focusing on the ambitions of policy and addressing some problems of governance that have resulted from the widening and deepening of policies towards research and innovation and ambitions to link the two.

5.1 The research and innovation bill of 2008

Swedish innovation policy has been described as follows: "Public innovation policy strategy is quite limited in scope and perspective. Almost all public research takes place within universities and university colleges, and innovations policy is mainly about how to transform and transfer research outcomes into innovation at the regional level". Thus, to understand Swedish policy development towards innovation and diffusion, one has to start by considering the role, structure and development of science and research policy.[36]

The political debate on the goals, level and structure of public research and innovation has been intense during the first decade of 21st century. The debate has emphasized several central goals such as: raising public investment in research to a target of one percent of GDP, finding an appropriate mix between investments on basic versus applied (or "needs-driven") research, how to achieve higher quality and excellence in research and how to stimulate increased transfers of technology from universities to industry.[37]

The research and innovation bill presented in 2008 can be seen as a turning point in many respects, tackling some of the above issues more thoroughly than before as well as introducing some new and novel instruments in the Swedish research and innovation landscape. The title of the bill contained, for the first time, both the words research and innovation (in Swedish: "Ett lyft för forskning och innovation"), and innovation was mentioned no fewer than 453 times.[38]

The bill meant a significant increase in government spending on public research, consisting of EUR 500m for the period 2009-2012. The Barcelona target of 1 percent was achieved in 2009. Most of the funds went to universities and university colleges following the suggestion that the new funds and 10 percent of the previous appropriations be distributed following a new system for quality assessments based on

[36] Lundvall (2008)
[37] . A detailed list on national innovation policy objectives and various instruments used can be found in Innovation-Policy Trend Chart for Sweden 2007, 2008 and 2009 see ProInno in list of references.
[38] According to SULF (2008)

research citations. These quality assessments will be implemented in 2012 for the allocation of parts of government block grants.[39]

The bill introduced new funding focused on 24 research areas that were considered strategically important to Swedish society and the business sector (Box 5.1). Some EURO 500 million were allocated for 2009 with the possibility of additional funding in 2010-11 and with the aim of reaching an annual level EURO 1.8b in 2012. The major part of this funding went to areas within universities where Sweden was already considered to be "world class and where society and the business sector have a major need for knowledge". These chosen areas were decided by government and allocated by competitive bidding thru the Swedish research council.[40]

Box 5.1 Strategic programs initiated in line with the new research policy

Swedish Research Agency

Cancer
Diabetes
Epidemiology
E-science
Molecular bio science
Nanoscience and nanotechnology
Neuroscience, inclusive brain (cerebral) and nervous system diseases
Political important geographical regions
Stem cell and regenerative medicine
Nursing research

Formas

Impacts on natural resources, "eco system services" and biological diversity
Oceanic environment research
Climate modeling

Vinnova

Sustainable use of natural resources
Material science
Production techniques
Security and crisis
Transport
IT mobile communication

Swedish Energy Agency

Energy

Source: Vetenskapsrådet (http://www.vr.se/forskningvistodjer/strategiskaforskningsomraden/20omraden43miljoer.4.56ec518312c85b30aa280003932.html

[39] Actually, the stated target was a total R&D intensity of 3 percent, where one third should be publicly-financed R&D.
[40] ProInno Inno-Policy Trend Chart (2009), pp. 12

The bill also introduced new initiatives to spur the commercialization of research results. A total of SEK 150m per year was allocated to 7 universities in order to strengthen existing initiatives at the universities with long term funding for a time period of 10 years. The initiative was labeled Innovation offices ("Innovationskontor") but did not imply the establishment of a new legal entity or organizational form; rather, the idea was to strengthen and leverage ongoing activities at universities. The overall motive behind launching the concept of the offices was to enhance commercialization and diffusion of research among Swedish researchers. Similar initiatives had already been established by Vinnova but with a smaller budget compared to the new initiative in the bill[41]. Each innovation office was free to organize its activities according to the objectives, needs and competencies of the university.

Clearly the new language and rhetoric in the bill was putting quite a strong emphasis on the transfer of knowledge from theory to application by stimulating universities to commercialize research knowledge (this will be discussed more in Chapter 6). Further, the bill set up a path to strengthen comparatively small Swedish Institute sector (see also chapter 3). The government stake in the Institutes had already been consolidated in beginning of new century by promoting mergers and co-operation to create stronger and larger institute blocks. In 2009 RISE Holding AB was created with the mission to partly or wholly own industry research institutes. In addition, the bill created opportunities for the Institutes to cooperate with both higher education institutions and businesses and to be enhanced through increased strategic skills development funds. The Institutes were also given opportunities to participate in the 24 new strategic initiatives.

Although the bill introduced innovation as an important ingredient in science and research policy, it did not break with the main characteristics of Swedish policy for innovation; namely, that university research is assumed to be both the major drivers and the recipients of the innovation system, playing major roles as actors within R&D in Sweden. Thus, the bill continued to build on a historical pillar with a strong university research system, general framework conditions for business and with some additional efforts devoted to linking the two.

5.2 Innovation policy

Public efforts to stimulate the diffusion and exploitation of knowledge and technology has been a regular policy objective before the 2008 bill was implemented, mainly through various technology push programs.[42] The early years around the new millennium saw, however, new methods and new policy rhetoric to describe the connections between research, innovation and growth by adopting concepts such as innovation systems and triple helix. In addition, these years also saw the establishment of the Swedish Agency for Innovation System, Vinnova, and the Swedish Agency for Economic and Regional Growth (at the time with named Nutek) as well as new emphasis on programs stimulating innovation in SMEs, regional innovation systems, clusters and large companies.[43]

[41] "Nyckelaktörsprogrammet".
[42] SeeStevrin (1977), Weinberger (1997) and also Benner (2009)
[43] Benner (2009) and ProInno, Innovation Policy Trend Charts for Sweden 2007, 2008 and 2009

Sweden has had a consequent ambition to stimulate collaboration between research and industry through various sector specific R&D-programs ("sektorforskning"). In practice these programs were officially abandoned in 2001. Policy ambitions to stimulate technological research and industrial development had already been high in the 70s and 80s with the creation of STU (Swedish National Board for Technical Development) with a mission to enhance the development of new technologies and diffusion to industry. Several new policy instruments were developed such as "ramprogram" and kompetenscentra (competence centres).

During the Social Democrats' government in the 1980s and early 1990s, growth and renewal were mainly seen as conducive of favorable conditions for business, which included macroeconomic stability and favorable general rules of the game for business.[44] The establishment of Vinnova in 2001 and the introduction of sector-specific research programs (branschprogram) in the late 1990s can be seen, however, as ingredients of a more ambitious and systematic Swedish innovation policy agenda.

The sector-specific programs had its roots in ambitions between some of the large unions (Metall), the employee federations and some of the ministries and state research agencies with the objective of cooperating and coordinating research investments for the benefit of Swedish Industry, mainly addressing the large companies' interests. A foundation for organizing the program was laid down by a large scale package to the by-then already-troubled SAAB which then was used to model new sector initiatives for automotive, forest and paper, aircraft and space, materials, IT and Telecom and Pharmaceuticals. The program was mainly directed towards the interest of the large companies, and Vinnova received an increased budget for the programs in the 2005 research bill amounting to SEK 120m for the period 2005-2008. Six of the programs have been evaluated by various consultants (see item 13 in Box 3.2). The programs will, however, be terminated in 2012.

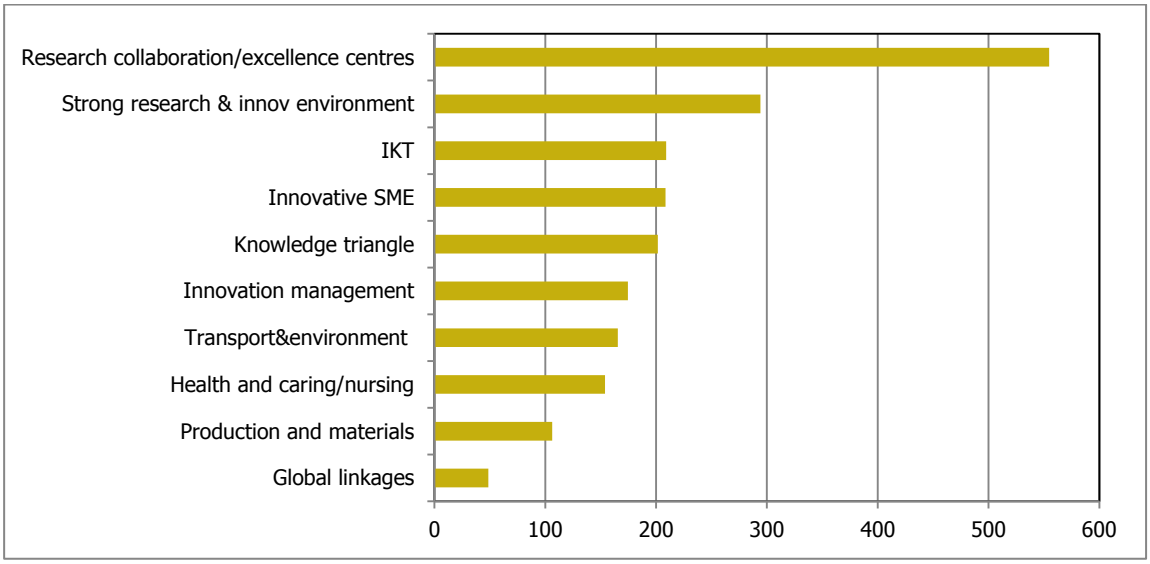
The establishment of Vinnova in 2001 marked a notable change in the Swedish institutional landscape of innovation actors. It started by diversifying its portfolio and introducing new programs for research cooperation (VINST), a program for enhancing research in SMEs ("Research and Grow," in Swedish: "Forska och Väx"), an incubator program for stimulating spin-off from research (VINNKUBATOR), which was followed by an additional program with the same objective but in cooperation with Innovationsbron, Industrifonden and a program for enhancing regional and sector innovation systems (VINNVÄXT). Program development was heavily influenced by the new innovation system agenda. However these programs were not large in overall budget the bulk of funding was still in various collaborative sector and technology specific R&D-programs. The assumed transformation mechanism was built on the notion of science as a source of innovation coupled with the effort to increase the linkages and cooperation between science and industry.

The current range of support measures of Vinnova is exhibited in Diagram 5.1. The portfolio has more than SEK 500m to its name and is geared towards "Collaborative programs." Within this area, programs require active interaction between private and public sectors. One of the largest programs in this area is the Vehicle Research Program

[44] See Benner, Deiaco, Edqvist (2007)

(FFP), which started when Ford acquired Volvo Cars in 1999 and GM took over the second half of SAAB automobiles in 2000. The aim of the program was to maintain important areas of knowledge in car technology.[45]

Diagram 5.1 Vinnova financed R&D 2010, SEK million, current prices[46]



Source: Vinnova (2011) Note: Research collaboration is the sum funding to different types of Excellence Centres

The innovation policy landscape has also seen a broadening of initiatives through an emphasis on SMEs and regional development under the umbrella of Nutek (now Tillväxtverket, the Swedish Agency for Economic and Regional Growth) with the mission to "work to achieve more enterprises, growing enterprises and sustainable, competitive business and industry throughout Sweden" (www.tillvaxtverkets.se). The establishment of Nutek (or rather a re-organization of the old Nutek) in 2001 was largely coincidental with the change in Swedish regional development policy from an emphasis on stimulating regional cohesion towards enhancing economic growth by stimulating innovation and entrepreneurship (prop 2001/02:4). For instance, each region is supposed to formulate regional development programs (where research, education and innovation are important), which is then decided on by the government and implemented through regional partnerships between various national and regional agencies and local businesses.[47] The budget for these regional initiatives amounts to considerable sums and an aggregate figure amounts to approximately SEK 10b.

These regional partnerships have often taken the form of various efforts of cluster building, financed by Vinnova (part of the program for strong research and innovation environments) and Tillväxtverket (Swedish Agency for Economic and Regional

[45] Inno-Policy Trendchart Sweden 2009, p 21.
[46] Vinnova (2011).
[47] See Tillväxtanalys 2011:01 The strategy for national competiveness, entrepreneurships and employment (2007-2013) form an important tool for pursuing the EU-shared goals for growth and employment and overall national goals in achieving the targets in the Europe 2020 strategy.

Growth). Studies by the Globalization Council indicated that Sweden has introduced several cluster policies during the last 10 years.[48] However, the empirical analysis also showed that there have been a falling number of Swedish clusters that are truly global leaders, even when Swedish overall global markets shares were holding up quite well. Thus, one overall policy conclusion from the analysis was that Swedish Regions do not have the absolute size to support a wide range of clusters. An overall policy ambition, according to the study, ought rather to be to encourage specialization and international linkages.

Reform ambitions throughout the last decades have, of course, also been geared towards enhancing the formation of new and growing companies. A new report has tried to depict the complex system that defines modern entrepreneurship and SME policy system in various countries and measuring the investments that goes to enhancing various forms of entrepreneurship. The system complexity mentioned above is related partly to the many different organizations involved in delivering resources in the SME area and partly to the many factors that, according to research, may influence the level of entrepreneurial activity.[49]

The report estimates the cost of these policies and these estimates show that a total of SEK 46.5b (EURO 4.4b) was invested in entrepreneurship and SME policy in Sweden for 2009 (Table 5.1). The share of small business support has declined during the period 2003-2010. However, most of the investments have gone to general SME-policy, funds to R&D and innovation is small in overall and is at the same level as in 2003.

The 2011 budget bill and the 2011 spring fiscal policy bill go further in reform ambitions (the concept used is structural policies) to enhance a dynamic and innovative business climate. The bill involves the following priorities and policy directions, among others:

- The government decide in January 2011 to appoint a broad inquiry into corporate taxation, with the aim of designing this taxation in such a way as to encourage investment and employment
- Measures will be implemented to strengthen the innovation climate, which includes funding for Almi's advising and mentoring activities and funding for innovations (through Innovationsbron)
- Strategic development programs for export advice for SMEs
- A special initiative to strengthen the capacity for development in the interior of northern Sweden in 2011 (Inlandsinnovation amounting to SEK 2b)
- An improved effort to increase the interest for STEM education (Science, Technology, Engineering and Mathematics)

The European state aid scoreboard follows the structural change in the member states. In Tabe 5.1 we see that Sweden belongs to the group of countries with less state aid.

[48] Ketels (2009).
[49] Tillväxtanalys (2011) 2011:03

Table 5.1 State aid as a proportion of GDP %

	2005	2006	2007	2008	2009
Austria/Österreich	0.3	0.3	0.3	0.3	0.3
Denmark/Danmark	0.4	0.5	0.5	0.6	0.6
Finland/Suomi	0.4	0.4	0.4	0.4	0.4
Germany/Deutschland	1.2	1.1	0.9	0.8	0.7
Netherlands/Nederland	0.2	0.2	0.1	0.1	0.2
Sweden/Sverige	0.3	0.3	0.2	0.2	0.2
United Kingdom	0.3	0.2	0.2	0.2	0.1

*Note: Total*aid: total State aid for industry and services (total aid less agriculture, fisheries and transport)*

Source : EU Commission
http://ec.europa.eu/competition/state_aid/studies_reports/expenditure.html

Table 5.2 exhibit that Several countries seems to have other strategies regarding their state aid w r t R&D and innovation. Austria and Netherlands allocates a larger fraction to innovation than Sweden.

Table 5.2 Share of State Aid on R&D&I w r t total state aid, per cent *

	2005	2006	2007	2008	2009
Austria/Österreich	24.7	25.2	31.6	40.2	44.5
Denmark/Danmark	4.0	5.5	6.4	11.0	11.5
Finland/Suomi	30.2	37.7	29.1	45.9	48.0
Germany/Deutschland	7.1	9.5	11.4	13.0	13.6
Netherlands/Nederland	43.2	36.6	42.4	41.1	54.9
Sweden/Sverige	10.9	11.9	17.5	17.6	20.6
United Kingdom	11.2	15.2	23.9	20.3	50.8

*Note: Total*aid: total State aid for industry and services (total aid less agriculture, fisheries and transport)*

Source : EU Commission
http://ec.europa.eu/competition/state_aid/studies_reports/expenditure.html

Following initiatives taken among municipalities in Sweden the government formulated a framework 2008 and 2009 for the provision of welfare services in health care and social services by private entrepreneurs. The primary concern was to provide options to choice in larger degree for the citizens and increase the accessibility of services. However from the government there are also expectations that the new more competitive arena for welfare services will induce innovation and higher efficiency. The reform parallels the deregulation of the pharmacy market. These parts of the service sector thus undergo large changes and to date it is too early to assess the effects from an innovation point of view.

Taken together, the above summary of various initiatives and policy directions show that, despite a lack of a Swedish official innovation policy in the past (but as mentioned a national innovation policy will be launched in 2012 by the government), quite considerable public sums (and several new policy initiatives and experiments) have been introduced and spent on enhancing transferring technology, encouraging

entrepreneurship and stimulating regional development. Thus, a major policy challenge will be to increase the leverage from these investments.

However, even if the aggregate sums have increased since 2008 the critics and debate have questioned how much that really went to actually stimulate innovation and diffusion. The research bill of 2008 increased funding for research and commercialization of technology from research, and the various regional initiatives stimulated general SME policy rather than entrepreneurship based on technological or non-technological innovation (e.g. innovation in private and public services).

5.3 Policy challenges

The description above indicates that there has been a widening and deepening of policies for innovation in Sweden during the last 10 years but the questions are: have these changes been conducive to effective innovation policy, and what measures are still missing?

The strong emphasis on STI and transfer of knowledge through universities have meant, according e.g. to Vinnova, that most funding activities have had little focus on the non-R&D activities demand (e.g., public procurement), and end users of innovation as well as on internationalization of research and innovation, although all this is increasingly recognized in the Swedish debate. Some critics have painted the lack of focus on demand as a significant weakness in the overall direction and efficiency of policy with the argument that especially for small countries most ideas based in scientific research come from abroad, and competitive advantage is advanced by integrating new ideas (from many different sources) in production processes, products and services.[50]

This in turn depends on not only depend R&D activities but also customers' and experts' competence and collaborative efforts over organizational, technological and geographical borders. To achieve these outcomes, many have advocated a better balance between supply and demand in overall policy development and an emphasis in overall innovation strategy to enhance innovative learning in various ways, thereby stimulating the increase of absorptive capacity and diffusion of knowledge in the economy.[51] Moreover, this highlights the importance of having access to a well-educated labor force as well as recruiting talent from abroad, and the results in Chapter 4 indicate that Sweden may have weaknesses in both respects.

There is an increasing awareness of the challenges and opportunities created by globalization, which implies a need to take part in transnational networks and in EU programs (and Swedish actors have improved participation in EU programs as well as getting large-scale funding in various scientific fields[52]). The research bill of 2008 had ambitions to tackle the question of internationalization, but in the end, other national priorities were considered more important.[53] Recent studies show the Swedish national innovations system having a strong international orientation when compared to other countries, yet Sweden is more oriented towards the US and Europe than emerging

[50] See e.g. Lundvall (2008).
[51] An early contribution was the Produktivitetsdelegationen (1991), for later discussion in years see Globaliseringsrådet (2009) and IVA (2011)
[52] The Royal Institute of Technology managed to get…in the EIT.
[53] Benner (2009)

markets and regions, although Sweden has a relatively favorable export balance compared to many other countries.[54]

As described above, the last ten years have seen new resources and many reforms in Swedish research as well as the introduction of innovation policy with the ambition to stimulate research and innovation in firms, regions and clusters. It is still too early to assess the overall efficiency of these reforms and initiatives, but one observation is that many of these still call for being properly evaluated in order to assess the outcomes and impacts on economic performance.[55]

The widening and deepening of innovation policies in Sweden means that governance issues have become central. Innovation policy comes in two versions, a narrow and a broad one.[56] The broad puts emphasis on basic framework conditions rather than specific sectors or technologies (the narrow one). The "systemic" or broad version implies that a fundamental aspect of policy is reviewing and redesigning the linkages between the parts of the system. The review above indicates that Swedish innovation policy has both a broad and a narrow perspective with a distinctive feature of commercialization of scientific outcomes into innovation at the regional level coupled with a strong STI bias.

The blend of both narrow and broad elements has, of course, triggered a fair number of debates on the proper design of innovation-enhancing policy, highlighting various problems and tensions of governance of policy. As seen in Chapter 3, the Swedish innovation landscape consists of many actors with varying degrees of coordination between ministries, funding agencies and other actors. In addition the Swedish Inno-Policy Trendchart report of 2007 added the following weaknesses in governance: A thin ministerial layer charged with policy formulation and semi-independent implementing agencies. A few strong stakeholders influencing the policy debate and propositions using statistics and biased information. Ad hoc processes for impact assessment of new regulations and a fragmented system for policy coordination. The trend in many countries is broadening the innovation policy strategies, but there is also some indication that this is less marked in Sweden than Finland or Norway.[57]

Policy debates have been further aggravated by specific problems in dealing with multi-level governance, particularly between regions and the state. The OECD Territorial Review 2010 for Sweden concluded that the national government and the municipal level hold the majority of power, while the regional level is weak.[58] For instance, the regional development programs are considered too broad in scope, not attached to any budget, not well connected with EU structural fund programs and suffering from the lack of an enforcement mechanism. These coordination challenges and other challenges related to the large spending on SMEs and sectors described above may result in significant efficiency costs and act as binding constraints to overall system efficiency, since it is well-known that overall system productivity in nations just as much as in firms depends on utilizing a variety of complementary input factors.

[54] Chaminade, Zabala, Treccani (2010)
[55] Svensson (2008)
[56] Lundvall and Borrás (2005)
[57] Lundvall (2008)
[58] OECD(2010c)

The expansion and experimental nature of policy action during the past decades in Sweden cannot, however, be automatically associated with better governance or better solutions to the specific policy problems in Sweden. The development of many different policy initiatives in various directions and with a wide variety of purposes does not necessarily mean that these solutions are effective and well-tuned to the needs of the overall system. The territorial review suggested otherwise on regional issues.

The question is whether this also applies to the governance and steering of research and innovation policy. An indicative assessment is shown in Table 5.3, which applies a framework developed by Borrás et al (2009) to specify various conditions for effective governance and various analytical criteria's for assessing the structure and development of innovation policy governance in Sweden.

This assessment may indicate that the rapid widening and deepening of Swedish policies for innovation is yet not always matched by effective mechanisms for innovation governance; however, further analysis is warranted.

Table 5.3 Effective conditions for innovation policy governance in Sweden? - A tentative assessment

Conditions for effective governance	Analytical criteria	Assessment of level and direction Swedish innovation policy
A strategic innovation policy	Existence of an explicit political vision and priorities	*A strategy is being formulated (2012)*
Coordination at the middle level of executive departments	Vertical and horizontal coordination to enhance synergies and complementarities	*Regarded to be problematic (lack of coordination between various ministries)*
A balance between diversity creation (enhanced by government) and market selection	Embracing change and adjustment	*Working well but policies are mostly supply-driven rather than demand- and entrepreneurship - oriented*
Clear distribution of roles between public and private actors	Extended contractual agreements in grey zones of public-private partnerships	*Both positive and negative experiences from government outsourcing*
Policy learning	Policy makers active development and use of strategic intelligence (indicators, policy benchmarks and foresight)	*Mostly reactive and discrete use (compared to e.g., macro indicators) but increasing in importance*
Public legitimacy	Existence of well-endowed participatory frameworks	*Dialogue platforms exist but are not well developed*

Source: Based and modified from Borrás et al (2009). Borrás asked what the independent variables (conditions) associated to the successful (or unsuccessful) governance, understood as coordination, suitability and reflexivity.

Various evidence guiding the assessment are: Bergström-Gergils (2006) IVA (2011), Benner (2009), Policy Trend Chart (2007 and 2009) and Tillväxtanalys, (2011f)

6 The role of universities for innovation and diffusion – Analysis of a specific sector

This chapter explores some of the factors behind a possible drop in quality of highly scientific research in Sweden in a comparative perspective and the direction and effectiveness of various policy efforts linking universities with industry.

The analysis in Chapter 4 observed a possible problem in the Swedish research system according to the indicator focusing on the performance of the research system. This indicator measured various aspects such as scientific co-publication, scientific citations and the number of non-EU doctorate students at Swedish universities. The statistics indicate that Sweden lags in development compared to the reference group in scientific quality and in the flow of foreign human capital. Below these trends are examined more in detail.

The Swedish paradox has often been used in the policy debate to frame the problems and challenges with university industry linkages and induced several policy reforms listed in chapter 3. However, quite a lot of new research point to the need to re-frame the challenges and opportunities of Swedish university and industry interaction.

6.1 Falling quality of research?

Universities are exposed to several pressures all over the world. On one hand, there is a search for excellence measured by the high output of scientific articles and frequent citations; on the other hand, they are expected to deliver useful knowledge to firms and organizations. Thus, there have been a series of ongoing reforms in many countries aiming at improving excellence and usefulness.[59]

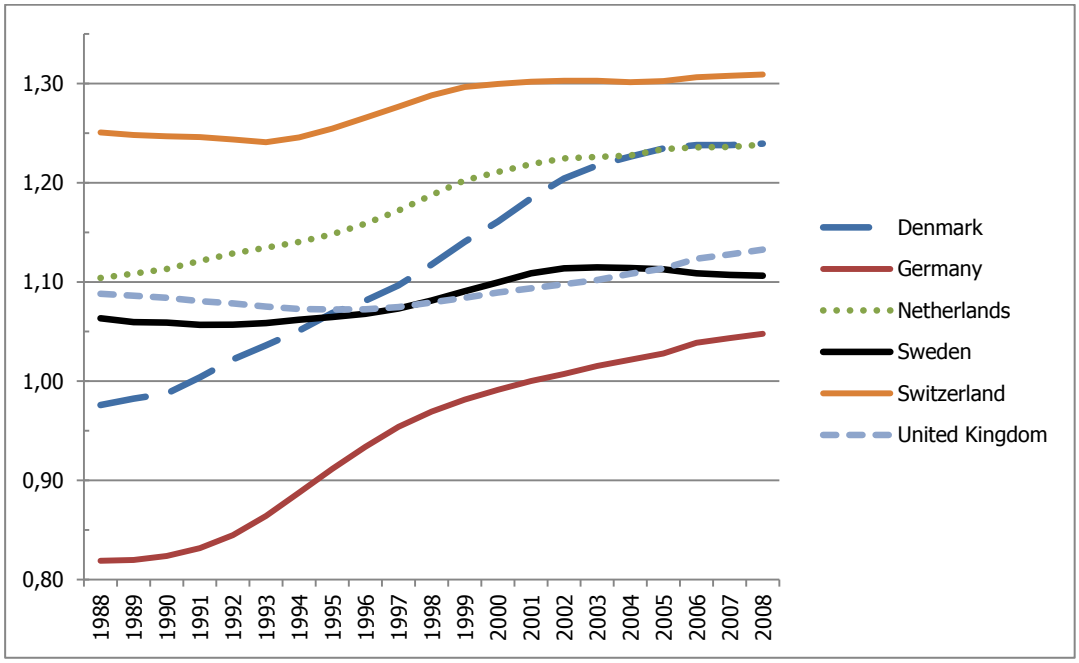
Scientific quality is, of course, only one of several factors stimulating innovative output in the economy, and not all companies are demanding high calibre research. But research has shown scientific quality and access to a highly-skilled labor force to be an important attractor for the location of firm R&D, and in an increasingly global knowledge market, these factors seem to become more important for location decisions.[60]

Given the methodological problems entailed in determining the best way to measure quality, recent evidence of international citations data seems to indicate that Sweden is losing scientific competiveness compared to a number of countries.[61] Diagram 6.1 shows the total field-adjusted citation frequency in a number of reference countries. A value of one indicates that the country has the world average citation frequency. Sweden and the United Kingdom have a fairly stable development, with a slight increase in citations in 1999 ending with a frequency of about 10 percent above the average citation frequency. The other countries have had a more pronounced positive development, although Germany is on a lower level than Sweden.

[59] See McKelvey and Holmén (2009)
[60] See Broström and McKelvey (2009)
[61] Vetenskapsrådet (2010)

In Diagram 6.2, we focus on quality publications by illustrating the frequency of Swedish publications among the 10 percent most cited publications.

Diagram 6.1 Field-adjusted citations 1988-2008



Source: Vetenskapsrådet (2010) Not: Avskuren y-axel i syfte att tydliggöra utvecklingsfasen

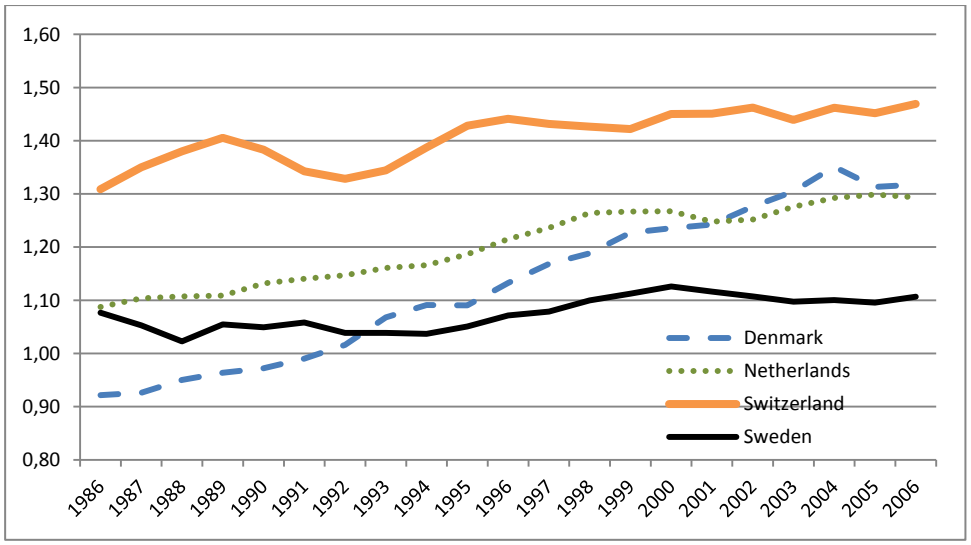
The evidence seems to indicate that Sweden has a relatively low proportion of highly-cited publications compared to a number of competitors in the global research arena. While the European reference countries have increased their citation rates, Swedish publications are cited at a high but constant rate throughout 1986-2006.

The analysis also shows that Sweden has few highly successful subject fields and that these areas of research produce relatively few publications per year. In addition, Sweden seems to have a low proportion of citations where all the authors have a Swedish address compared to the reference countries, which may indicate a lower degree of high caliber international collaboration.[62]

The report conducted by the Swedish Research Agency also tried to explain some of differences between the mean citation rates among Sweden with the reference countries. The analysis concludes that the major part of the difference must be related a low proportion of highly-cited publications in Swedish research performance.

[62] Vetenskapsrådet (2010)

Diagram 6.2 Field-adjusted citation frequency in relation to top 10 percent most cited publications



Source: Vetenskapsrådet (2010). Not: Avskuren y-axel i syfte att tydliggöra utvecklingen

A new report has analyzed Nordic university performance at the single university level by looking at publication and citation levels and rates of growth. Again, the Swedish indicators stand out in a number of respects and some of the evidence is summarized below:[63]

- Denmark stands out among the Nordic countries with a substantially higher citation impact and publication growth.
- Sweden has the greatest publication activity among the Nordic countries but slow growth (Health and Biomedicine accounts for 51 percent of the publication volume).
- There are large variations between Swedish institutions with several universities having falling publication rates, particularly among Swedish hospitals.
- The citation data also shows that Sweden has lost its longstanding edge in clinical research. This can be explained partly by deteriorating funding to this area and partly by a marked slowdown in the willingness among medical doctors to pursue graduate studies in clinical areas.[64]
- Stockholm University is one of the most highly-cited universities in the Nordic countries, but in general, few Swedish universities have citations among the top 10 percent that are highly cited. In this respect, the Danish (and the Swiss) have more universities that are among the top 10 percent.

The falling scientific quality has been discussed in the Swedish debate from different angles and a number of hypotheses have been put forward trying to explain the changes. Economic research has shown that disbursement of funding and the autonomy of universities to be particularly important for explaining differences in university

[63] NordForsk (2011)
[64] SOU (2009)

performance between US and European universities, and we present some evidence below to compare the performance of universities in different countries.[65]

Table 6.1 presents relative country performance looking at the top 50, top 100, top 200 and top 500 universities in the Shanghai ranking. The best university is given a score of 50, the next best 49 and so on.[66] For each country, the sum of the top 50 rankings are computed and divided by the population and then country score are divided by the US score. Thus for each column the number relates to the US=100 score. The evidence in the table indicates that US performance completely dominates all European countries in that column for the scores of the top 50 universities, and it is only the Swiss and UK universities that rival the American universities among the top 50 universities, even though they still lag far behind the best universities in the US.

Among the European countries, Swedish, Swiss and UK universities dominate the top tier, where Swedish universities are doing particularly well in the top 100 but not as well as Swiss, UK, Dutch and Canadian universities among the top 50 universities. Again it seems that Swedish universities, using other indicators than citations, have a lot of universities with good scientific quality but few of them that belong to the top level internationally.

Table 6.1 Shanghai ranking of universities, Country performance index (US 100)

Country	Top 50	Top 100	Top 200	Top 500
Massachusetts	449	308	302	263
California	234	199	163	103
Switzerland	97	166	228	230
UK	72	86	98	124
Canada	39	54	63	104
Netherlands	20	51	76	131
Sweden	7	117	179	217
Denmark	0	75	114	161
Finland	0	46	75	81
Germany	0	17	37	67
Austria	0	0	0	53

Source: Aghion, et al. 2007

If research points to the level of autonomy and the existence of competition for funding to explain performance, one may ask how Swedish universities compare with some of the European countries. On the positive side, evidence shows that Swedish universities have considerable per-student budgets and more wage setting and hiring autonomy compared too many of the European countries. A distinctive feature of Swedish research is that a significant part, measured in man-years, is conducted by graduate students.[67] The one indicator where Sweden stands out is in faculty with higher proportion of in-house PhDs, particularly in comparison to Swiss and Dutch universities, which are highly open to scholars with PhDs from other institutions[68]. Available evidence indicate

[65] See Aghion et.al. (2007) and Himanen et.al. (2009)
[66] *Ibid* Aghion, et al.
[67] Deiaco, Gierz, Reitberger (2002)
[68] *Ibid* Aghion, et al

that less than a quarter of those employed and with a doctorate degree in Swedish universities have their degree from another university.[69]

These international indicators point to some of the challenges for Swedish universities in the global race for prestige and highly-cited articles. Swedish research has also tended to focus on various deficiencies in the levels and structure of research funding. Clearly public R&D did not increase during the early years of the new millennium, but the research bill of 2008 adjusted for the slowdown of the early years. As many researchers have indicated, however, the high intensity of Swedish R&D is inflated by a few large multinational companies. Public investments in R&D are not particularly high compared to other countries' rates of investment.

The Swedish university system has undergone considerable changes. External funding has increased considerably of total university funding. In addition, Sweden has some 39 higher public education institutions and during the last ten years former university colleges have received status as universities. Both of these two trends have resulted in a polarization of resources in the Swedish university sector.[70] As an example of this polarization, smaller universities and university colleges generally report quite a large size of research subjects relative to their size (and sometimes equal to the larger universities), but they do not have many researchers. The figures therefore can be interpreted that many of the research subjects in these new HEIs are fairly empty and lacking in critical mass to some extent, which may lead to lack of competitive and international specializations.

As shown in Chapter 5, concentrating resources in order to build critical mass has been high on policy agenda, although the critical voices from researcher in various scientific fields suggest that funding is still low compared to funding efforts in other countries. In order to increase critical mass and scientific quality, various large scale funding programs (often under the name of strategic research) have been initiated during the last ten years by both the public research agencies and the so called research foundations. However, there are some signs that the focus on large scale research funding has not yet delivered as promised (measured in citations). A new report in 2011 showed that funding to various strategic research programs has not yet increased citations. Thus, the overall verdict on these large scale investments is still to come.

In conclusion, there is a strong policy debate advocating for and policy reforms implemented to increase the scientific performance of the Swedish university sector. By 2012, a new competitive resource funding mechanism will be implemented in allocating block grants to universities in a more competitive manner. At the same time, a reform will be in place, which is intended to increase the level of autonomy for Swedish universities in a number of respects.

However, the poor development of high-level Swedish research quality is not yet fully understood and suggests a need for more-thorough analysis of the factors that determine the performance of high caliber and dynamic research environments (Sörlin-Benner 2009). International research indicates that the factors behind decreasing quality are not only to be found in the level of funding but rather in how funding and various

[69] Reitberger & Sittenfeld (2011)
[70] (Ljungberg, et al. (2009)

organizational factors contribute to a dynamic research environment (Heinze, et al. 2007). Competitive recruiting both on a national and international scale seems to be particularly important, as the international evidence suggests, Swedish universities have a higher proportion of faculty that has been recruited in-house compared to Swiss and UK universities. Although further analysis is warranted, the development in Sweden over the past decade may have created a situation where researchers at the best universities do not teach, teachers do not conduct research and professors have to chase down external funding from many different sources in order to cover large parts of their own salary as well as the salaries of the members of their research groups.

6.2 Academic entrepreneurs and commercialization of research

Sweden has had a rather long history of various collaborative policy efforts trying to link science with industry in order to improve research, innovation and diffusion. One strand has been geared towards improving research collaboration between industry and university (which was described in chapter 5) and another more recent in improving the commercialization of university research through patents and university start-ups which will be the focus of this section. The "Swedish paradox" has been the intellectual backbone of many of these public initiatives to enhance academic entrepreneurship and commercialization, and the innovations offices described in chapter 3 have been a recent policy initiative.

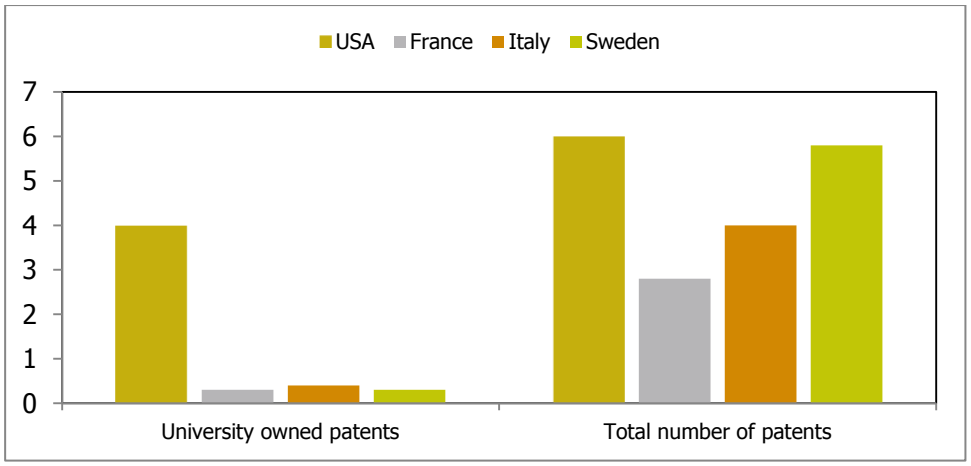
The Swedish approach to linking universities with industries has worked under the assumption that the link will not come automatically and is, therefore, in need of various public funding mechanisms, particularly when it comes to commercialization of university research and often with a top-down approach according to the critics.[71] Thus, the research question that has occupied researchers and policy makers has been how to analyze how well Sweden performs and in what ways it differs when compared to the best performers, which often have been American university efforts in building TTO offices.

Recent studies indicate that Swedish universities have been better at innovation compared to what the paradox hypothesis (especially the part that looks at commercialization of university research) seems to suggest. For instance, the number of Swedish European patents with a direct origin in Swedish universities amounts to 5 percent (and another 2 percent from various organizations in the public sector), which is considered high in an international perspective.[72]

Comparative data also suggest that academic scientists' contribution to national patenting in France, Italy and Sweden is similar to that found for the USA,[73] correcting for ownership of patents. In contrast to the USA (where the university owns the patent), European businesses own 60 percent of academic patents and with higher share in Sweden in comparison to France and Italy (Diagram 6.3).

[71] Henrekson-Rosenberg (2001)
[72] Tillväxtanalys (2011d)
[73] Lissoni, et al. (2009)

Diagram 6.3 The share of university patents in US, France, Italy and Sweden, per cent



Source: (Lissoni, et al. 2008)

Evidence comparing single universities is even scarcer, but indicators of patent proportions seem to show that Lund Univ., Uppsala Univ. and the Karolinska Institute account for half of all academic patents in Sweden (in 2006). Another case study at The Royal Institute of Technology recently has shown, in an a large effort to measure commercialization, and found that it had the same level of start-ups as MIT and number of patents as Cambridge per R&D Swedish crowns invested.[74]

If, therefore, the problem with the transfer of technology, given the above figures, lays not among the universities (and the single researchers) the search for the pros and cons of existing policy and policy rhetoric requires more research attention. First, knowledge about the various motives for collaboration between industry and universities has deepened and shown a much more complex pattern, whereas access to new useable technology is only one of several motives and perhaps not the most important. A number of new international studies have painted a much more complex picture between the linkages of science and industry in Sweden and elsewhere.[75]

Secondly, measuring only the number of start-ups or patents will elicit only a small part of the knowledge exchange between the sectors (Wright et.al. 2008). There are good reasons that focusing on indicators measuring only patents and start-ups gives an incomplete description of commercialization processes. Thirdly, a number of studies have shown that the efficiency of TTO offices or other instruments for advancing the diffusion of research hinges to a great extent on the overall transfer strategy of the university, the skills of TTO managers and the organization and incentives of actual transfer mechanisms at the single university (Siegel et.al. 2007).

Unfortunately evaluations of Swedish policy instruments for enhancing collaboration are scarce. Some critics, however, point to the fallacy in the basic premise, implied by the paradox and the resulting design of Swedish policy instruments. It has been suggested that policy design in Sweden has rested on the assumption that research and commercialization activities are substitutes rather than complements. But a significant

[74] RAE (2008)
[75] Hughes and Kitson (2011)

amount of new evidence seems to show that in engineering scientific publishing does not substitute for commercialization activities. On the contrary, they seem to be complementing each other.

As has been mentioned, Swedish public policy to enhance commercialization has been focused on creating new start-ups from well-established researchers. This has in general been shown to be costly and difficult, although Sweden has produced several success stories. But a new study shows that during 1994 to 2001 528 spinoffs from Swedish universities were observed compared to 8663 corporate spinoffs.[76] The evidence point to that the corporate spinoffs perform better in terms of survival as well as growth. Thus, spinoffs from academia represent only a small path of knowledge-intensive entrepreneurship. Other strategies such as for instance stimulating efforts directed towards students have also been less prominent in the Swedish system, but have shown to be rather important in terms of new companies and regional employment in international universities.[77]

To support commercialization, many universities have established specialized support structures such as transfer offices (TTOs), science parks and incubators. At present, Sweden has some 42 technology parks and a national incubator program[78]. Evaluations show mixed signals on the efficiency of parks and incubators. A recent study on commercialization in engineering among Swedish universities have shown that university incubators does not have a significant effect in patenting but rather a positive effect on spinoffs indicating that they may fulfill their role successfully for university employees starting companies. TTOs on the other hand influence patenting in Swedish engineering sciences but not in terms of spinoffs.

The new knowledge and evidence about academic entrepreneurship and commercialization seem to suggest a more complex process and interplay between research, support structures and individual academic engagement. Thus, in Sweden the role of interaction, engagement, contact, access and mobility has been getting more attention in enhancing knowledge spillovers. Again, indicators of the extent of various forms of structural mobility between universities and firms are scarce, but various case studies show room for considerable improvements and some results for 2000-2008 are presented below:[79]

- Slow increase of number of adjunct professors in Sweden (medicine accounts for large share of increase)
- Adjunct professors constitute 4.6 percent of total professors in Sweden
- About 100-159 persons adjunct in technology areas financed by the private sector
- Almost exclusively men
- On average, 25 percent of working time during 20-40 FTE years

[76] Wennberg, Wiklund, Wright (2011)
[77] Åsterbro-Bazzazian (2010)
[78] Innovationsbron is running the incubator program financed together with Vinnova.
[79] Reitberger–Sittenfelt (2011)

A recent survey indicates a slowdown in the development of industrial PhDs at various universities.[80] Interviews with large manufacturing firms in turn indicate the "private sector post-doc or senior researcher positions are a flaw in the Swedish system. Furthermore, strategies at universities and companies are relying on legacy relationships and are often on an ad hoc basis". Instruments and degrees of freedom at universities are in place to enable larger use of temporary employment contracts but are not used fully due to e.g., narrow interpretations of credit evaluation. Some companies have also stated that their strategic use of adjunct professorships is not always optimal regarding how that knowledge is used for technology planning and development within the firm.

[80] Reitberger G & Sittenfeld J (2011) p 34f

7 Innovative performance in Swedish industry

The Swedish innovation policy debate with regard towards companies has been centered on a number of issues related to the structure of industry, including the strong dependence on a small number of old, large, globalized companies, whose innovative contributions to the Swedish economy have been, according to some, waning over time. Furthermore, evidence has been put forward showing Sweden lagging behind other countries in the absence of new high growth in innovative small and medium-sized companies. The same evidence suggests that Sweden is one of the least specialized economies in the EU (European Commission 2010 and Globaliseringsrådet 2009). This chapter describes and discusses these issues in some detail. How has specialization and renewal of innovation evolved in Swedish industry during the last decade? To what extent are the above claims still valid?

The claims somehow imply that the level of innovativeness (and ultimately Sweden's capacity to produce new jobs) in Sweden is being endangered by this unfavorable industrial structure. We do not say that this is wrong, but find evidence that provides greater nuance for the issue. We argue that globalization of R&D and innovation challenges the way value is created in small, open economies like Sweden's, particularly since more and more of the production of goods and services is conducted in discrete stages in global value chains and in specific regions around the globe. Measuring this kind of innovation and enterprise dynamic is difficult, however, and relying on the simple one-dimensional indicators as in chapter 4 will be misleading in diagnosing and framing the challenges ahead as well as directions for future policy.

The following chapter analyzes these issues from the perspective of how the specialization of Swedish industry has evolved and Sweden's capacity for renewal of old and new firms.

7.1 Specialization in the Swedish NIS according to export statistics

The level and degree of specialization in the economy is an important driver for innovation. To characterize specialization is, however, difficult given the quality of internationally comparable data. The most common measure is to calculate Revealed Comparative Advantage (RCA) indexes for different countries on sector or product aggregates. If the RCA indicator is above 1, the country is considered specialized in that sector or product.[81]

Table 7.1 show the number of sectors among 68 sectors that have an RCA value higher than one or above for each of the selected countries in the reference group. First, Sweden

[81] The revealed comparative advantage (RCA) measures the intensity of a country's trade specialization within the world market. Calculation: Export share of a product (SITC) of the total exports (of goods) of a country divided by the export share of this product (or type of goods) of the region or the world (here: UN). An RCA value less than 1 implies that the country is not specialized in exporting the product (type of goods). The share of that category of goods (SITC) within the total exports of goods of this country is less than the corresponding world share. Similarly, an index exceeding 1 implies that the country is specialized in exporting this type of goods. (OECD stats)

has 28 sectors with specialization, a number exceeded by only Denmark, which has 29. Second, almost all Sweden's RCA values lies between 1 and 2, which means that these sectors are specialized but only slightly above the average on this level of aggregation. Third, three Swedish sectors have RCA values above four which are pulp, paper, and wood, the industries usually brought up when characterizing Swedish specialization patterns. Denmark and Finland have higher degrees of specialization with a larger share of RCA values above 2.

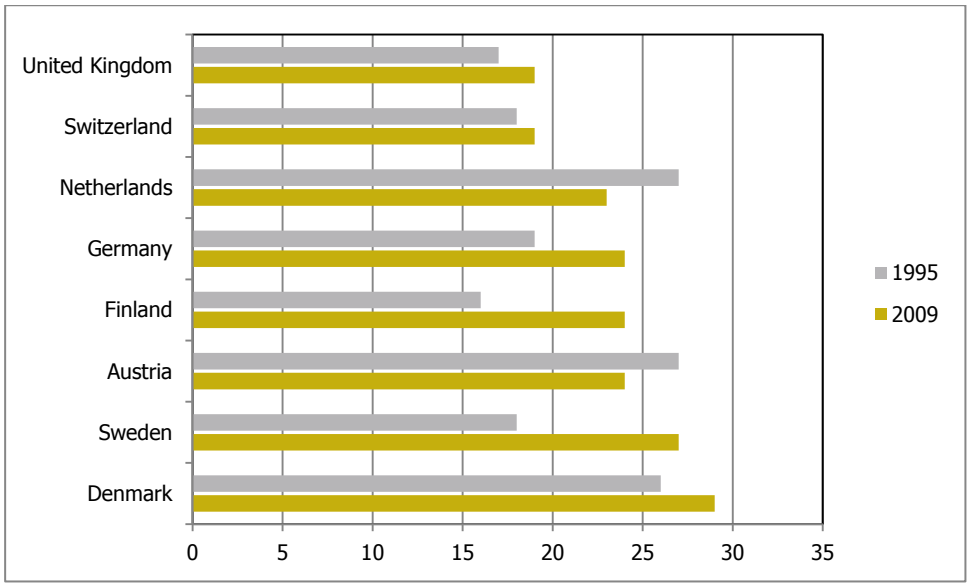
Table 7.1 Number of sectors where RCA is above 1 distributed into RCA size-groups, Sics 2 digit level, 2009

	RCA>1	1<RCA<=2	2<RCA<=3	3<RCA<=4	4<RCA
Austria	24	14	6	2	2
Denmark	29	20	6	1	8
Finland	24	13	5	0	6
Germany	24	22	2	0	0
Netherlands	23	13	5	4	1
Sweden	27	23	1	0	3
Switzerland	19	12	4	2	3
United Kingdom	19	14	3	1	1

Source: OECD stats Globalization Micro indicators on trade

When we look for changes over time (Diagram 7.1) Sweden is the country which has had the largest increase in the number of specialties between 1995 and 2009. Thus, in a period of strong globalization and rapid technical change, Sweden has, therefore, managed to broaden its degree of specialization into more sectors.

Diagram 7.1 Number of sectors 2-digit SICS with RCA above 1, 1995 and 2009



Source: OECD stats Globalization Micro indicators on trade

This renewal has, of course, created winners and losers, and Table 7.2 lists the sectors where Sweden has lost or gained in specialization. Sweden has lost ground in core sectors of the Swedish economy such as telecom, motor vehicles and the manufacture of

metals. All the same, these sectors represent products with high value added for Sweden; this development is in line with the projections made by Rae and Sollie (2007) with an increased competition from emerging countries. Sweden has attained specialization in new areas such as fish and beverages (which probably is explained by a large export from mainly Norvegian owned companies in Sweden).

Is the above stated profile of Sweden's specialization a sign of increased vulnerability or is it an indication of the limited validity that the RCA indicator might have at this level of aggregation?

Table 7.2 RCA indication of Sweden's gains and losses in specialization

Increases in specialization		
New areas	Fishery	Misc. edible products
	Beverages	Animal or vegetable fats & oils
	Dyeing, coloring Materials	Plastics in non-primary form
Old areas	Pulp	Paper
	cork & wood	
Losing ground	Telecom	iron & steel
	manufacture of metals	road vehicles
	other transport equipment	
Sweden no specialty traits		mineral fuels

Using more disaggregated Swedish data gives a more adequate picture of the degree of specialization (Table 7.3). Sweden has almost 7000 different export "products," but not all of these have equal importance in terms of the export revenue generated. Instead, Sweden's export value is dominated by a limited number of products. Some 100 products amount to 50 percent of the export value, and as few as 10 different products amount to as much as 20 percent of the export value. These 10 products are listed in the table below, which show that Sweden has large revenues in pharmaceuticals, telecommunications technology, vehicles and pulp and paper where Sweden ranks among the five largest exporters in the world. These products are dominated by large international corporations located in Sweden like Astra-Zeneca in pharmaceuticals, Volvo Cars, Ericsson, Volvo trucks and Scania trucks, and Stora Enso, Holmen and SCA in pulp and paper products.

The evidence above only lists, however, the largest revenue products these corporations produce. The indirect influence these large corporations have on companies and sub-contractors in other sectors is probably as significant or more when it comes to their actual importance in Sweden. The following sections will therefor look into the renewal of old and new firms and the complex interdependencies that characterize innovation in the Swedish economy.

In conclusion, the evidence suggested by the RCA statistics seems to be in line with the general picture of the Swedish NIS given in Chapter 2 as having been largely flexible and successful in a time of large global changes but also showing some signals of losing competiveness in core sectors of Swedish industry. In addition, Swedish specialization

shows a high concentration of a limited number of mature "products," which might explain the sense of vulnerability often found in the Swedish policy debate[82].

Table 7.3 Sweden's 10 most important "export products" 2005

Relative frequency with regard to total exports	cum rel freq	Product code in the combined nomencl	Value in Euro billion	Product description (Combined nomenclature)
0.04	0.04	30049019	4.02	Medicaments consisting of mixed or unmixed products for therapeutic or prophylactic purposes, distributed in forms or packages for retail sale (excl. medicaments containing antibiotics, medicaments containing hormones or steroids used as hormones, but not containing antibiotics, medicaments containing alkaloids or derivatives thereof but not containing hormones or antibiotics, medicaments containing pro-vitamins, vitamins or derivatives thereof used as vitamins and medicaments containing iodine or iodine compounds)
0.04	0.08	87032319	3.76	Cars and other motor vehicles principally designed for the transport of persons (other than those of heading No 8702), incl. station wagons and racing cars, with spark-ignition internal combustion reciprocating piston engine, of a cylinder capacity > 1.500 cm³ but <= 3.000 cm³, new (excl. 8703.10-10 and 8703.23.11)
0.03	0.11	85252099	2.67	Transmission apparatus for radio-telephony, radio-telegraphy, radio-broadcasting or television, incorporating reception apparatus, (excl. that for radio-telephony and radio-telegraphy for civil aircraft of subheading 8525.20.10 and for cellular networks "mobile telephones")
0.02	0.13	85299040	2.02	Parts of radio-telegraphic or radio-telephonic transmission apparatus, transmission apparatus incorporating reception apparatus, still image digital video cameras and portable receivers for calling, alerting or paging, n.e.s.
0.02	0.15	87033219	1.88	Cars and other motor vehicles, principally designed for the transport of persons, incl. station wagons, with compression-ignition internal combustion piston engine "diesel or semi-diesel" of a cylinder capacity > 1.500 cm³ but <= 2.500 cm³, new (excl. motor caravans and vehicles specially designed for travelling on snow and other special purpose vehicles of subheading 8703.10)
0.01	0.16	27101945	1.41	Gas oils of petroleum or bituminous minerals, with a sulfur content of > 0,05% but <= 0,2% by weight (excl. for undergoing chemical transformation and for undergoing a specific process as defined in Additional Note 4 to Chapter 27)
0.01	0.17	47032100	1.14	Semi-bleached or bleached coniferous chemical wood pulp, soda or sulfate (excl. dissolving grades)
0.01	0.18	85173000	1.03	Telephonic or telegraphic switching apparatus
0.01	0.19	87012010	0.98	Road tractors for semi-trailers, new
0.01	0.20	85179082	0.96	Electronic assemblies for electrical apparatus for line telephony or line telegraphy, incl. for line telephones with cordless receivers, and for videophones, n.e.s. (excl. for telephonic or telegraphic carrier-current line systems)

Source: Tillväxtanalys (2009)

7.2 Renewal in the Swedish economy

Innovation dynamics imply continuous change and several factors influence this change. The factors of renewal we focus on are:

- R&D development among businesses
- Renewal by the means of other intangible investments

[82] Attention is needed to construct better measures indicating the specialization of countries NIS. Relying on RCA based on 68 sectors cannot be considered adequate.

- Innovation activities among enterprises
- Renewal by the means of new entrepreneurship
- Renewal by the means of new forms of interaction in the value chain where the role of the service sector increases in importance

7.2.1 Renewal by the means of R&D

In the innovation discourse the importance of knowledge creation and knowledge exploitation are core issues. This is the main reason why R&D as an input factor gets so much attention in innovation analysis. In general, however, we know very little about how R&D expenditures relate to domestic growth. From a business perspective, R&D expenditure is motivated by hopes to enhance the enterprise's ability to compete in the market. Sweden's high R&D intensity emanates primarily from market-based decisions in a limited number of large corporations. According to the Swedish R&D survey, enterprises with 250 employees and more accounted for over 80 percent of the total R&D expenditures in the enterprise sector.

Compared to other European countries and our selected reference group, however, Sweden is not an extreme case of highly concentrated R&D expenditure (Table 7.4). According to the statistical survey produced in May 2011 by the Ministry of Enterprise Energy and Communication, smaller enterprises (fewer than 250 employees) in Sweden have higher R&D expenditures than our comparison group. As for the largest corporations, the Swedish fraction is above 80 percent, which is high but not the highest (far right column). It is slightly higher in Germany, the UK and Finland.

Table 7.4 R&D in realation to GDP, Distribution of in enterprise sector 2007, per cent[83]

	1	2	3	3/(1+2+3)	4
	10-49	50-249	250+	Largest enterprises as % of all R&D	5 largest R&D performers share (%) of all R&D*
Germany	0.05	0.13	1.58	89.8	57
United Kingdom	0.04	0.14	0.94	83.9	26
Finland	0.18	0.26	2.01	82.0	88
Sweden	0.17	0.31	2.17	81.9	74
Switzerland (2004)	0.15	0.27	1.70	80.2	80
Netherlands	0.07	0.15	0.75	77.3	76
Austria	0.13	0.32	1.21	72.9	58
Denmark	0.15	0.30	1.21	72.9	

*Source: Swedish Government (2011a) primary source *Entreprenörskapsforum (2010) p 111*

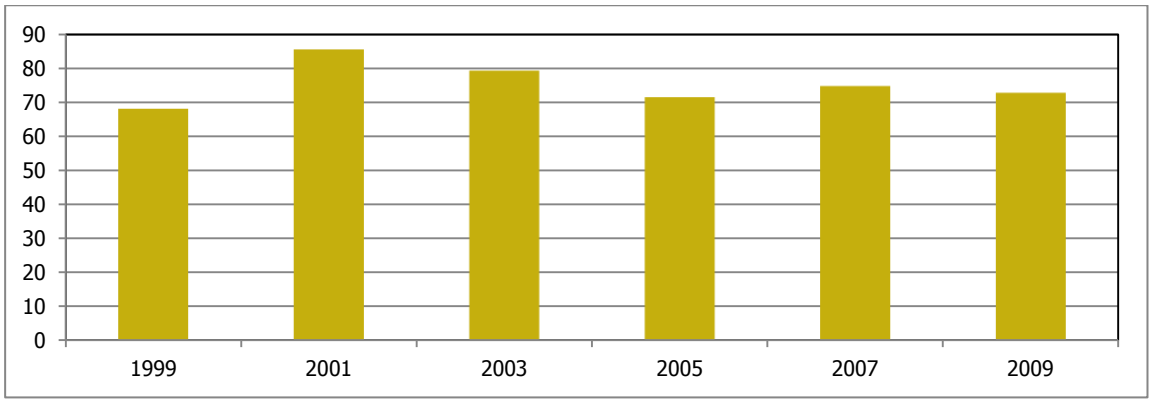
In column 4 is exhibited the proportion of the five largest enterprises with respect to R&D in relation to total R&D among all enterprises traded at public stock exchange. Sweden do have a high concentration but it is not unique among other small countries.

[83] The recently published Innovation Union Competiveness report on p 314 shows dramatic BERD for SMEs share increases for Denmark and Switzerland in 2008 at 10 and 22 percent units, respectively.

If R&D in the private sector is an important innovation indicator, the pattern in Sweden over the last ten years needs further attention (Diagram 7.2). Sweden is often recognized as having large R&D investment but given this, the development over the last ten years can be interpreted as no significant changes in R&D levels. In fixed prices, the 2009 level is SEK 5b above the level of 1999, or an average annual increase of less than 1 percent. The estimated values for 2010 indicate a further decrease. If we compare with the pre-crisis year of 2007, the decrease is even larger, SEK 7b. The year of 2001 has been considered as inflated by extreme usage of external consultancy in R&D enterprises (mainly Ericsson). Depending on how we interpret the 2001 level, we get two alternate stories: One saying that there seems to be a decrease in R&D investment and another saying that there seems to be no increase in R&D investment. Neither is very comforting.

What dynamics have governed this development? What we do know is that before 2007, the increases in R&D mainly occurred in the service sector, while between 2007 and 2009 the R&D in the service sector has decreased the most.

Diagram 7.2 Total R&D expenditure for enterprises with size 50 employees and more, billion SEK 2009 prices



Source: Statistics Sweden

A decomposition of the R&D expenditures in manufacturing and services and size groups gives a preliminary picture that the latest decreases are mainly due to the decrease of R&D in the services sector (Table 7.5). As for size groupings, the smallest firms are the ones with the largest relative and absolute decreases, while the large enterprises have actually increased their R&D between 2005 and 2009 while decreasing somewhat between 2007 and 2009. We can also see that in recent years, the services sector decreased its R&D levels by more than 20 percent, while the manufacturing sector increased theirs by 5 percent.

A significant part of the high Swedish R&D intensity is due to a large concentration of high multinational R&D performers. The 20 largest Swedish corporations with SEK 41b account for approximately 52 percent of private R&D-investments localized in Sweden. Besides this, the largest 20 also invest another SEK 35b overseas. Small and medium-sized companies spend less on R&D compared to large ones, although this indicator must interpreted with care given that many of these companies are knowledge-intensive business companies where competitive advantage is not created through R&D but on new business models, advanced logistics, etc.

However, what is striking in the Swedish context is the rather high share of foreign-owned companies in overall R&D spending. The deregulation reforms in the early 1990s included permission for foreign ownership of stocks traded at the Stockholm stock exchange. As a result, a surge in acquisitions followed in the manufacturing sector as well as for the service sector. By 2003, the foreign takeovers stagnated and, in fact, since 2007 (Diagram 7.3), a decrease in employment in foreign ownership can be observed. As for 2010, 13,627 enterprises with 590,304 employees (22 percent) were classified as having foreign ownership, an increase of 30 percent in five years. In general, foreign ownership is connected to larger knowledge flows and spurring innovation in technologically-advanced sectors (Aghion, et al. 2010).

Table 7.5 Absolute levels of R&D expenditure (BERD) Swedish enterprise sector,SEK millions in 2009 prices[84]

2009 prices	1999	2001	2003	2005*	2007	2009	Rel. change 1999 ->2005
50+	68 174	86 666	79 442	71 613	74 974	72 968	1.07
BNP	2 559 690	2 707 402	2 839 446	3 053 242	3 289 985	3 108 002	1.21
10-49				7 014	5 594	5 080	0.72
50-249				9 849	10 090	9 495	0.96
250-				62 189	65 540	64 056	1.03
Manufacturing				57 224	56 903	59 557	1.05
Services				21 827	24 320	19 073	0.78
With regard to international businesses							
In Sweden localized R&D within Swedish owned enterprises				40 466	48 579	44 531	
R&D in Sweden in foreign owned enterprises				32 952	31 417	23 261	
20 largest Swedish Corporations							
R&D in Sweden	31 029	39,991	30 086	34 057	44 231	40 876	
R&D localized in high income countries	22 537	29 105	22 139	25 136	30 922	31 975	
Localized in low-income countries	144	620	634	1 673	1 558	3 250	

Source: Statistics Sweden (2010) uf14sm1001 and Tillväxtanalys (2011c)

**Change in population in R&D-survey. 50+ indicate same population as previous: Non-financial firms sized 50 and above. 10-49, 50-249, 250- also includes enterprises in financial sector. Sums thus do not match.*

It's difficult to empirically evaluate the effects of foreign acquisitions; however, it seems as though from the scattered evidence regarding levels of investment, exports, imports and value added, the foreign enterprises are on par with internationally active Swedish firms and higher than Swedish national firms.[85]

Decreased employment in foreign-owned enterprises is, however, concomitant with a decrease in the R&D expenditures of these enterprises by almost SEK 9b. Since 2005,

[84] Note 1: BERD implies that R&D financed by the state is included in the enterprises expenditures. Note 2: The division on enterprises according to ownership (i.e. international firms), the numbers are sensitive to changes in the population and thus only can be interpreted as indication of a certain dynamic.
[85] ITPS (2007).

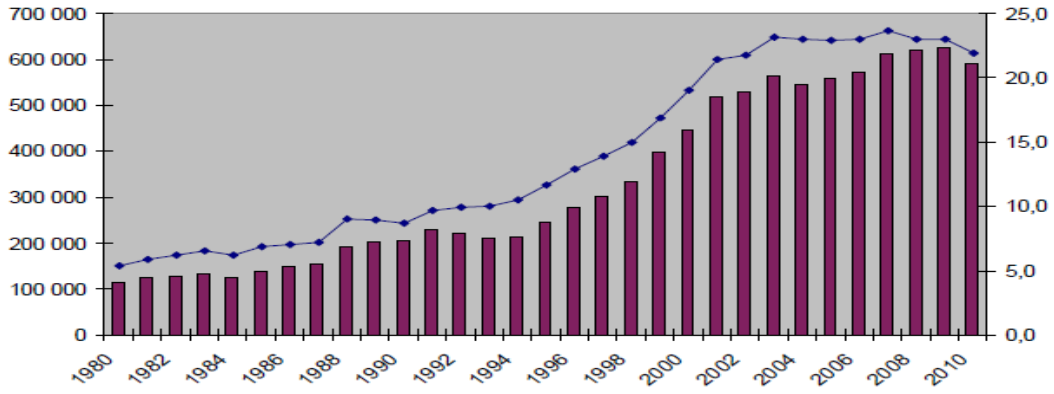
large Swedish-owned corporations have also increased their overseas investments in R&D by about SEK 7b. Adding the SEK 10b invested in R&D in Sweden results in a sum total of SEK 26b. Thus, among the international businesses investment decisions between 2005 and 2009 regarding R&D locations has amounted to approximately SEK 22b.

Besides this, we can also draw the following preliminary conclusions from Table 7.5 that since 2005:

- R&D conducted by small enterprises (10-49) has decreased by SEK 2b, almost a third.
- Swedish-owned enterprises with 50 employees and more have increased their R&D by more than SEK 8b. The biggest increases are mostly in the large corporations.
- Manufacturing increased R&D, and within it primarily the old core industries like pulp, paper, and vehicles,
- R&D in services has decreased.

The financial crisis of 2008 and its aftermath initiated a need to survey the largest corporations in both manufacturing and services to determine whether the crisis would lead to further re-assessment of R&D expenditures. In Box 7.1, parts of the results of the survey are presented. The main conclusion regarding R&D is that most corporations will not alter their current engagement. Few companies will in a 5-year horizon decrease their R&D-investments. More than 10 percent plan to increase.

Diagram 7.3 Employment in Sweden in foreign owned enterprises, number (bars) and percent (line)

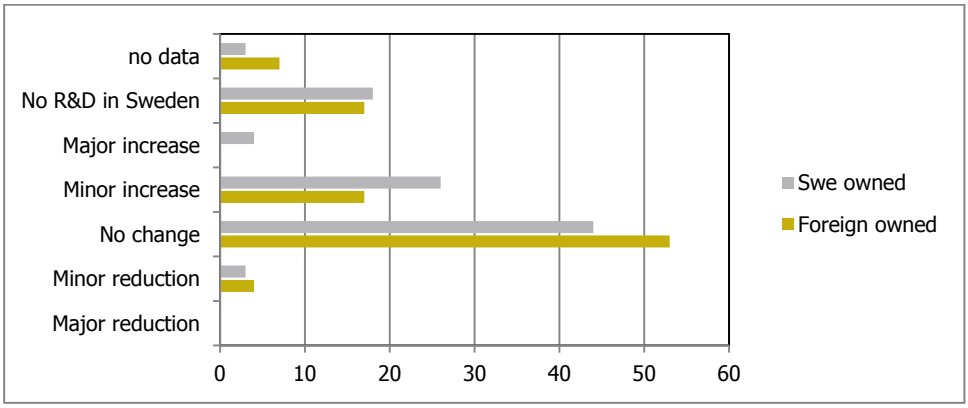


Source: Tillväxtanalys (2011c)

Box 7.1 Survey of Large enterprises R&D strategies in the aftermath of financial crisis

Due to the financial crisis, the Swedish Agency for Growth Analysis (Tillväxtanalys) performed a survey on the largest enterprises in 18 industries, both national and international, regarding relocation issues in the next five years. The answers to the question regarding R&D show how these companies value the co-location between R&D and production facilities (Diagram 7.11).[86] According to the survey in 2011, over 40 percent of the large enterprises will maintain their engagement in Sweden in the next coming years with regards to R&D and approximately 20 percent plan to increase their R&D.

Diagram 7.4 How will the level of R&D develop in the next five years?

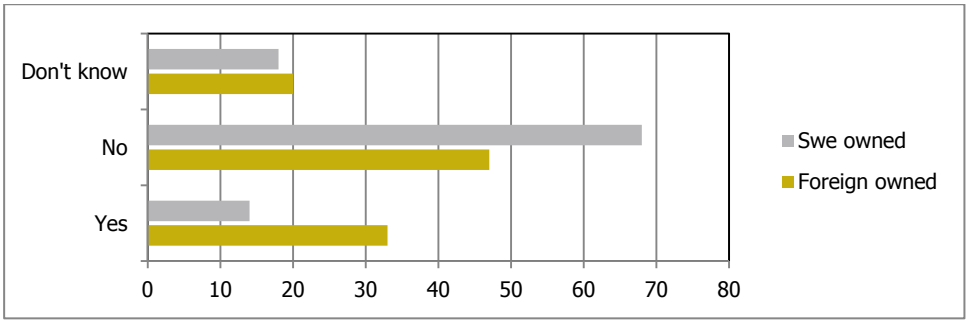


Source: Tillväxtanalys (2011a)

Note: Percent sums to 100 per ownership

Next, regarding the sensitivity of co-location between production and R&D facilities, the survey measures a difference between types of ownerships (Diagram 7.12). It is shown that Swedish-owned enterprises will take relocation of R&D into consideration to a lesser degree when relocating production than foreign-owned enterprises.

Diagram 7.5 Will R&D facilities relocate if the production relocates from Sweden?



Source: Tillväxtanalys (2011a)

These figures show the importance of gaining and retaining attractiveness in the global economy. Other changes in the evolution of innovation provide similar challenges.

7.2.2 Renewals by the means of other measures of intangible investment

Since Corrado, et al.'s (2005) seminal paper, R&D is not only considered expenditure but also an investment together with other intangible investments. In principle, the intangible investment perspective tries to decipher parts of the TFP and includes the following:

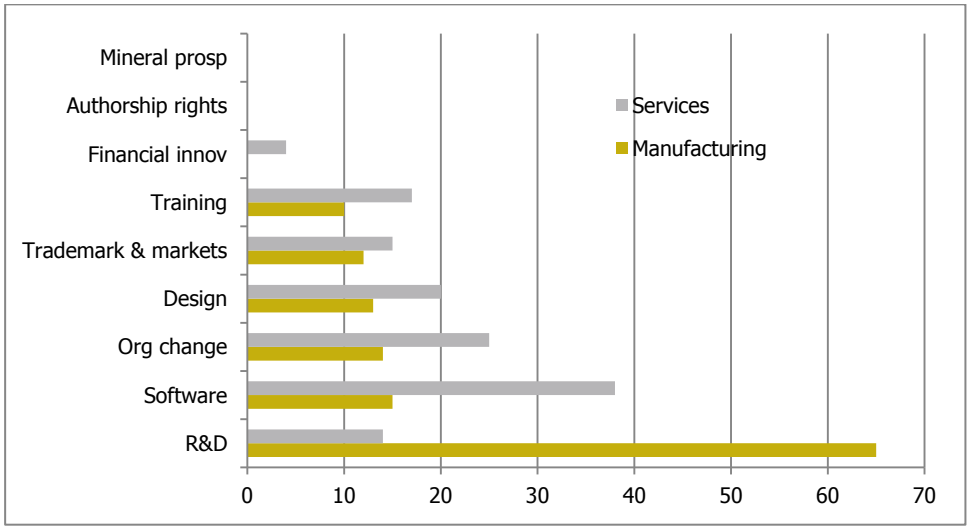
[86] The survey focused on the 18 largest enterprises in 18 sectors. 324 enterprises were approached and the response rate was 91 percent.

- R&D
- Mineral exploration
- Authorship/copy rights
- Product development in the financial industry
- Design
- Trademarks and marketing
- Training (skills development)
- Organizational change (management)

Investment means that the effect of an outlay will remain longer than a year. In the list above, for some items like organizational change only a fraction is considered as investment. OECD (2010) has published results of evaluations of intangible investments, and in this report, we only underline two aspects of the issue.

The first aspect of note is that according to Van Ark, et al. (2009), there seems to be a difference between the allocation of investment in intangibles between more and less advanced countries in that the former invest much more in intangible capital. The second aspect of note is that the structure of intangible investments is of another character in the service sector compared to manufacturing; although the totals are almost equal. We see from Diagram 7.6 that besides the investment in R&D, the service sector invests more in all other identified areas of intangible investments. Over time, there is also evidence that the manufacturing sector invests a larger share in intangible investment than in tangible (ordinary capital investments). These results point in two directions: one is the resemblance in core activities of the two sectors; another is the question of whether this trend in investment patterns needs a policy consideration.

Diagram 7.6 Allocation of intangible investments in manufacturing and services in Sweden 2006, SEK billion



Source. Tillväxtanalys (2010)

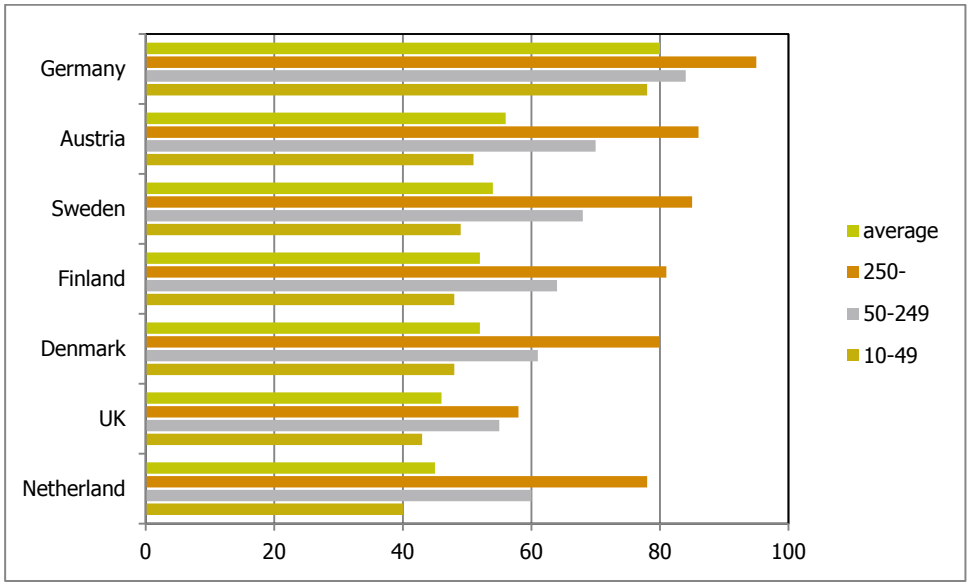
7.2.3 Renewals according to innovation survey

While R&D and investments in intangibles are costs incurred for the purpose of generating income for the enterprise, there are few measures of the results of these investments besides the revenue figures of the enterprises. The Community Innovation Survey (CIS) tries to measure the frequency of innovation among enterprises. Two indicators should be kept in mind when comparing countries. First, it is the realized

productivity which drives economic development in countries, not the indicators. Second, indicators of innovation have been correlated with productivity, which is positive, but they are not found to be the sole determinants (Hall 2011). Therefore, the CIS output indicators must be interpreted with care. In the latest CIS survey, two indicators of special interest are first, the number of enterprises actually performing innovation activity, and second, how much of the total revenue among enterprises emanates from new products or services.[87]

Diagram 7.7 indicates that Sweden has similar values to the other countries in the reference group. Germany stands out with a high share for all size groupings.

Diagram 7.7 Share of enterprises with innovation activity 2008 average and distributed on size w r t employment (Switzerland's average is 62).

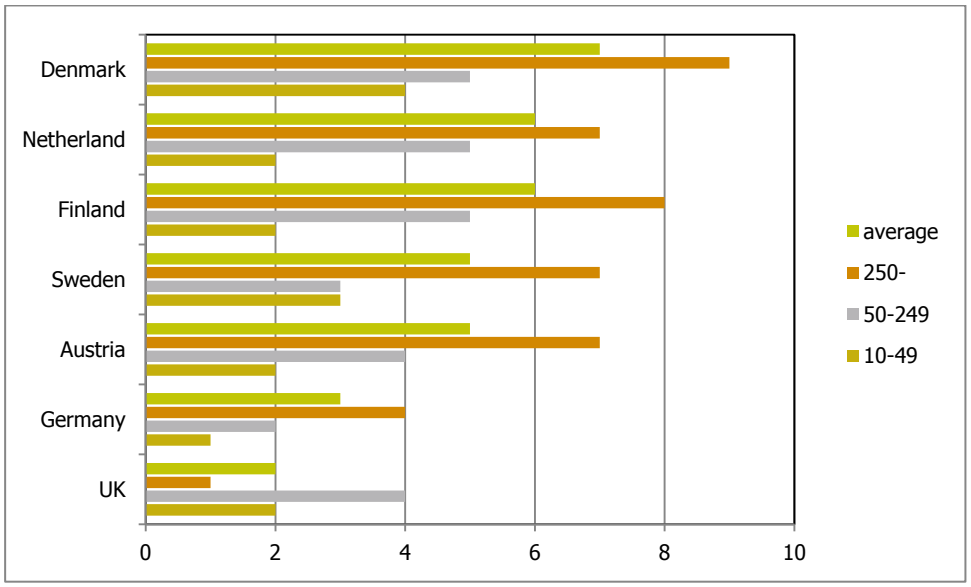


Source: Eurostat CIS 2006-2008 survey. Note: Survey data implies random errors.

As for the proportion of revenue from innovations (Diagram 7.8), the estimate for Sweden's enterprises places the share in the middle of the group of reference countries. The enterprises in Denmark seem to have a higher revenue share from their innovations. If this is a consequence of a particular Danish structure thus warrants further analysis. Note that the strong estimate for innovation activity for Germany does not seem to spill over to a large share of revenue on innovation.

[87] Innovations activity is defined as introducing a new product/service or process or abandoning a process with the intent to introduce new products/processes or an enterprise with these kinds of ongoing activities. "New" is qualified here as "new to market," which is considered a stronger version of innovation compared to "new to the firm."

Diagram 7.8 The proportion of revenue in 2008 from products and services which are new to the market in relation to total revenue, percent (Switzerland's average is 8)



Source: Eurostat
Note: Survey data imply random errors

In sum, from the CIS indicators, we do not find that Sweden trails the reference group in innovation activity. These indicators have been criticized primarily for uncertainty regarding what kind of conclusions can be legitimately drawn from figures like the two above.

7.2.4 Renewal and innovation via entrepreneurship

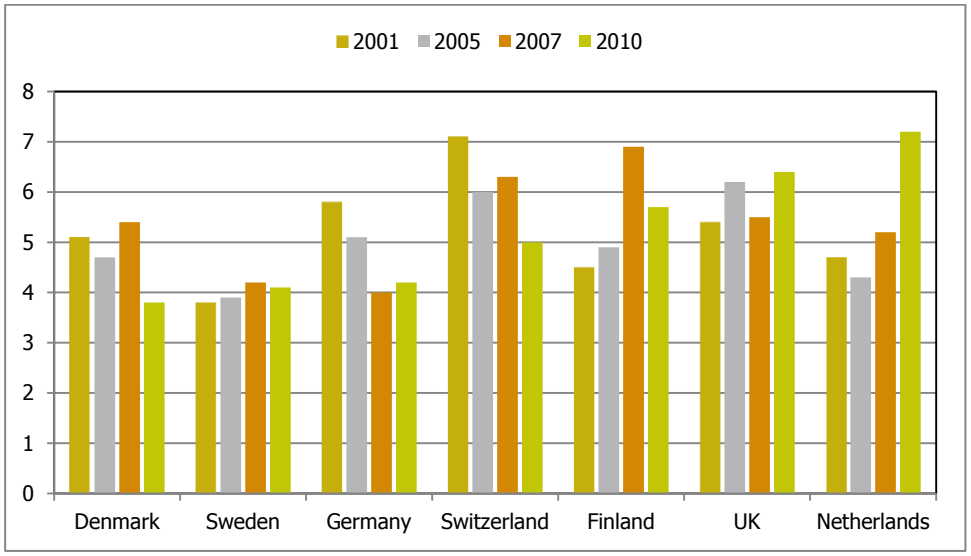
Innovation is integrated in the dynamics of entrepreneurship, but there are also huge problems regarding how to measure entrepreneurship and its contributions to innovation and productivity.

One reason for this difference is that the indicator is dependent on how other policy areas are formulated. Entrepreneurship policy discussions rely on the concepts of necessity-driven and opportunity-driven entrepreneurship. In general, poor countries have high number of start-ups, which are considered "necessity-driven." The reason is that there are too few large organizations which hire people in these countries. The Global Entrepreneurship Monitor (GEM) survey investigates this by asking the respondents the reasons and the prospects for their planned or recent venture. The GEM indicator Total Entrepreneur Activity is a sum of the number of individuals (aged 18-64) planning to start a business, nascent entrepreneurs and the number of recently-started entrepreneurs. This sum is related to the total of individuals between 18 and 64.

The TEA-indicator exhibits another story than Eurostat data (Diagram 7.9). Here Denmark has low values and Switzerland has high values, contrary to the EUROSTAT start-up data. Sweden has low values, although a weak improvement might be interpreted from the data conforming to the perception of a country with low enterprise start-up activities. The GEM is a survey with such problems with random errors. Thus,

confidence intervals imply that there are no significant differences between our selected countries with the exception of the Netherlands. [88, 89]

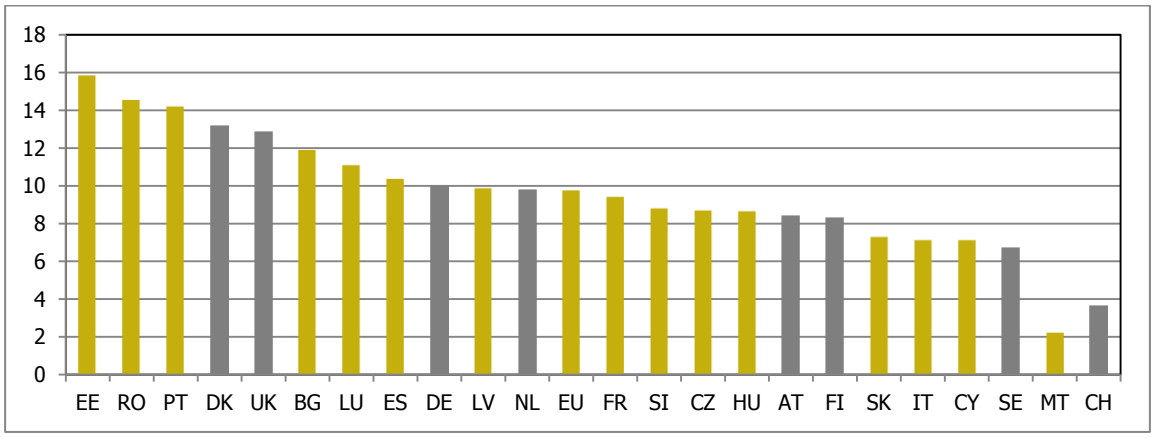
Diagram 7.9 GEM's TEA indicator, per cent



Source: Entreprenörskapsforum (2011), attachment in web-edition

Another data source on this issue is Eurostat's collection of statistics on business demography. From a policy perspective, the churn rate of the enterprise stock is an indicator of the renewal of the economy. The churn is the joint effect of the following indicators: the number of start-ups or the "birthrate," the survival of these and the number of enterprises exiting the population. From the Eurostat data in Diagram 7.10, we see that the birthrate differs between member-states and also between the selected countries we focus on. Switzerland, 3.8 and Sweden, 6.7 are the lowest according in our group of countries with regard to enterprise birthrate.

Diagram 7.10 Enterprise birth-rate, business economy 2006 in percent



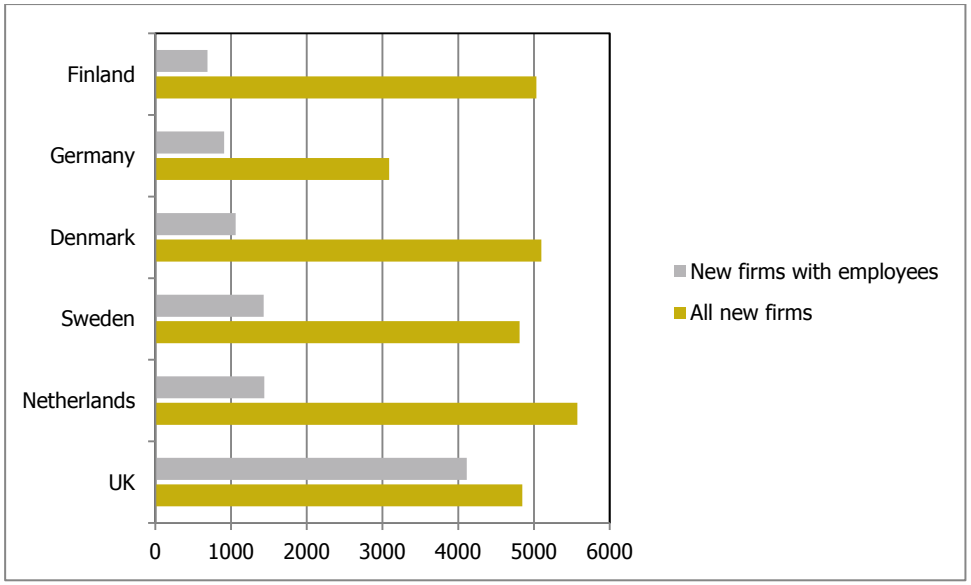
Source: Eurostat (SBS)

[88] This proposition is judged from the exhibit 1.3 p 13 in Entreprenörskapsforum (2011)
[89] Swedish Government (2011a)

The debate often gets stuck on this simple indicator regardless of the fact that the total renewal or "churn" also depends on the survival or the possibility to prosper once you have started an enterprise and the exiting of non-profitable ventures. The Eurostat indicator for survival of an enterprise as 2 years old puts Sweden at the top, and the rate of exits in Sweden seems to be quite low. Thus the net effect of the birth-rate in Sweden might not be what a simple conclusion would suggest based on Sweden's relatively low level in comparison to the reference group.

Another perspective is however given if the number of new firms is related to the number of inhabitants in the country. This gives an indication of the climate form entrepreneurship in general and if the indicator is qualified to the new firms with employees it serves as a crude measure of a more ambitious entrepreneurship (Diagrams 7-11). The data from Eurostat suggest that Sweden has more new firms with employees than Germany, Denmark and Finland. With 1431 enterprises with employees per million inhabitants, Sweden is almost on par with Netherlands 1440. The number from the UK differs very much from the rest suggesting that there might be differences in the treatment of zero employees in the UK comparing to the rest.

Diagram 7.11 Number of new enterprises per million of inhabitants, 2007



Source: Eurostat SBS dababase on business demography

Acs & Szerb (2010) have made a contribution to illustrate this dynamics. Recently, they argued that the focus on "simple" indicators as TEA and birthrates has been charged with the major shortcoming of not considering the quality of entrepreneurship and that "they do not capture quality differences across entrepreneurial activity, such as opportunity recognition, skills, creativity, or innovation and high growth."[90]

In other words, in order to evaluate the "quality" of entrepreneurship, one has to put the statistics into a specific context. The Global Entrepreneurship Development Index (GEDI) is an elaboration of the current stock of indicator information, which tries to consider the "quality" perspective. By interacting statistics on "individual" levels with

[90] Acs & Szerb L (2010)

statistics on "institutional" levels, the 14-indicator constructor is divided into three entrepreneurial dimensions: Attitude, Activity and Aspirations. The GEDI does not collect new information, but puts together data from GEM, the World Economic Forum (Global Competitive Index), Doing Business, and Transparency International into one index on Conditional Entrepreneurship (Table 7-6).

Sweden fares well in the GEDI and ranks number 4 among the 70 countries for which the index has been computed (Table 7.6). From the table, we can also see that Denmark is ranked number one, while United Kingdom ranks as number 14 despite its high rankings in the TEA and birthrate statistics. The GEDI is the average of the computed indices for Attention, Activity and Aspiration, and we see that Sweden lags far behind Denmark in the Activity index.

Table 7.6 GEDI-index 2010 on entrepreneurship [91]

	GEDI	g rank	ATT index	at rank	ACT index	ac rank	ASP ind	as rank
Denmark	0.76	1	0.75	5	0.97	1	0.57	6
Sweden	**0.686**	**4**	**0.77**	**4**	**0.71**	**7**	**0.57**	**5**
Switzerland	0.63	7	0.60	12	0.73	6	0.56	8
Netherlands	0.62	10	0.70	7	0.66	12	0.48	16
Finland	0.56	13	0.69	9	0.62	14	0.39	24
United Kingdom	0.56	14	0.60	11	0.66	13	0.42	21
Germany	0.54	16	0.45	24	0.62	15	0.56	7
Austria	0.45	22	0.55	13	0.47	22	0.34	30

Source: Acs & Szerb (2010) Note: Rounded to two digits

Table 7.7 exhibits the decomposition of the Activity index. This index consists of information regarding the degree of *opportunity-driven* entrepreneurship, which is the "sum" of a GEM statistic and a composite index of business burden statistics from the Doing Business survey. Second, the *technology sector* index interacts with the TEA businesses in GEM, which are active in medium and high tech sectors with the indicator of absorption capacity from the Global Competitiveness survey.

Table 7.7 GEDI Activity index decomposed

	ACT index	Opportunity start-up	Technology sector	Quality of human resources	Competition
Denmark	0.97	1.00	0.95	1.00	0.92
Switzerland	0.73	0.66	0.84	0.84	0.80
Sweden	**0.71**	**0.89**	**0.49**	**0.49**	**0.82**
Netherlands	0.67	0.74	0.76	0.43	0.89
United Kingdom	0.66	0.73	0.54	0.58	0.87
Germany	0.62	0.58	0.85	0.41	0.80
Finland	0.62	0.76	0.61	0.56	0.59
Austria	0.47	0.61	0.46	0.21	0.83

Source: Acs & Szerb (2010)
Note: Rounded numbers

[91] Sweden the GEDI build from data of 2007while Sweden not supply data to GEM for 2008 and 2009

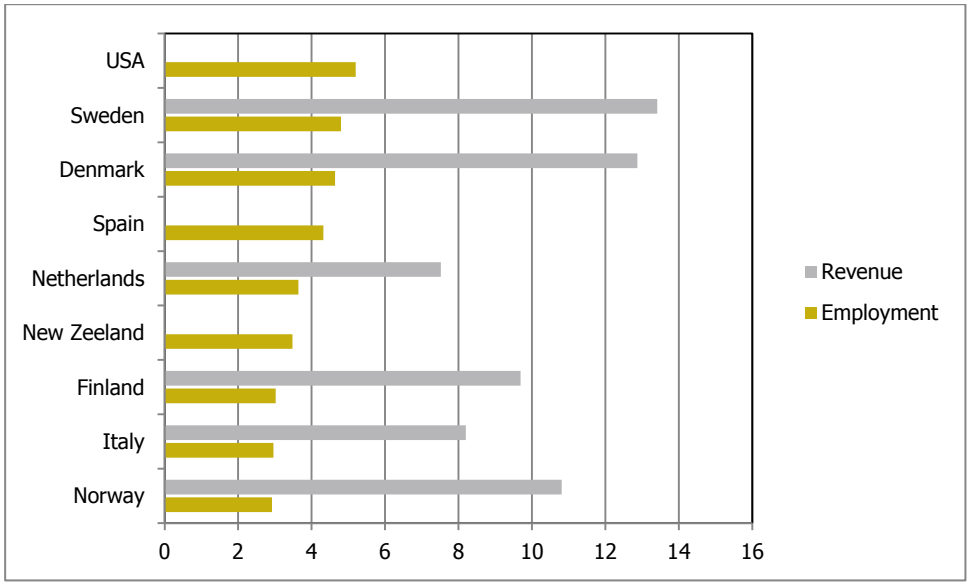
The third indicator, *Human resource,* puts the share of TEA businesses in interaction with each country's value on GCI survey regarding the amount of personal staff training in the business sector. The fourth indicator, *competition*, interacts with the share of TEA businesses venturing into new markets with few competitors and the value of general market dominance by large corporations according to the GCI-survey.

It must be noted that the distances between the countries are not easy to apprehend, but Denmark clearly stands out as having a climate supporting high indices. In all sub-indicators, Denmark has values above the rest. Sweden ranks second in the indicator on opportunity start-ups but are weak in the others.

The GEDI is a new index, the validity of which needs to be discussed in more detail. Still the GEDI index confirms that Sweden also ranks highly from an entrepreneurial perspective, where innovation and high growth considerations matter. This is not to say that Sweden does not have any problems at all. The GEDI suggests that areas like the quality of human resources and technology sector entrepreneurship need both attention and further analysis.

In recent years, a discussion on the importance of so-called high growth enterprises has flourished. For a venture to have an impact on general growth and structural change i.e., creative destruction, it must be on a path of high growth within a limited number of years after its birth. An indicator of the number of such high-growth enterprises might thus a candidate for an efficient NIS. As a witness of the importance of this indicator, we referred to the forthcoming indicator of high growth enterprises in the IUS scoreboard (not yet ready for publication). Eurostat has compiled statistics for a small group of countries, which are presented below (Diagram 7.12). In comparison to Denmark, Finland and the Netherlands (all of which are included in the Eurostat sample), Sweden has a larger proportion of high growth enterprises both with respect to revenue and employment growth in 2007.

Diagram 7.12 Proportion of high growth enterprises 2007 w r t growth in employment and revenue, per cent



Source: Swedish Government (2011a), primary source Eurostat and OECD

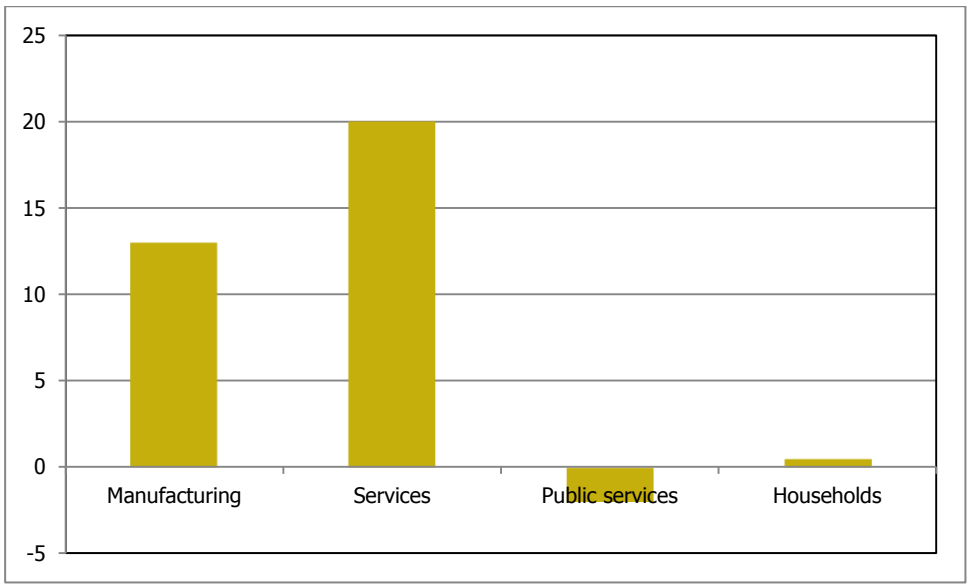
In summary, many governments try to search for a new Google or Microsoft. This is a valid objective for policy but, as history shows, a difficult one as well. It will certainly be important to enhance further growth of these companies even if development in Sweden has shown thus far that many have failed to grow to a large size and are commonly bought up and assimilated by large foreign companies (Gierz 2011). Whether this is positive or negative is often debated, but existing tax policies for stock options for individuals inside these companies may have contributed to this development in Sweden and some of the main arguments for tax policy ambitions are discussed in section 7.4.

7.2.5 Innovation in services and service innovation

As the industrial structure of rich countries has shifted away from products towards the delivery of services, sector leaders have become increasingly aware that technical change and R&D describe only some of the sources of increased productivity in the economy.

Diagram 7.13 shows the productivity contributions of various sectors in the Swedish economy. It is still a fact that productivity growth is higher in manufacturing than in the heterogeneous service sector, but as an aggregate, services are becoming more important. In order to determine the relative contribution to aggregate productivity, a shift-share analysis shows that the private service sector contribution to labor productivity was higher than manufacturing from 1994 to 2009 but, and as expected, with rather large variations between service sectors in terms of productivity levels and contributions. More detailed analyses show that personal services have slow productivity development (lower than manufacturing) and "förmedlingstjänster" (brokerage) has almost the same productivity development as manufacturing. Producer services showed weak development through the 1990s, but had the same high development as manufacturing during the last decade.

Diagram 7.13 Contribution of various sectors to productivity growth in Sweden, 1994-2009, percent units



Source. Tillväxtanalys (2010b)

The increasing availability of data and attention to services has increased the understanding of the contribution of services to innovation and productivity in the Swedish economy and the challenges for scope of national policy (Box 7.2 summarizes some main observations from various studies on the role and development of services and contribution to innovation and productivity). But the key thesis that these new studies imply is that a competitive service and industrial sector are simultaneously developing at an increasing rate in Sweden.

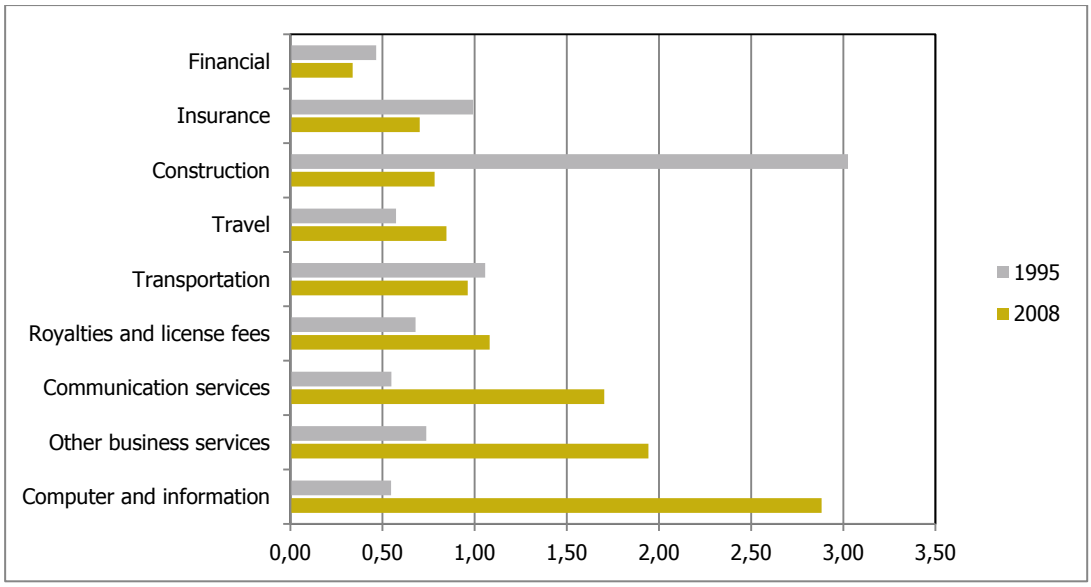
For example, the interplay between large multinational companies in Sweden and the development of knowledge-intensive business services (KIBS) also appears in productivity and export statistics. Sweden has seen impressive growth in KIBS during the last decade. The contribution of KIBS to productivity in the service sector is high, and their contribution to employment growth in the sector is highest in the period 1994-2007 (Tillväxtanalys 2010:13). How much of this increase is due to outsourcing from manufacturing and how much of it represents increased demand cannot be adequately calculated. Regardless, when business tasks can be digitized and activities can be unbundled, it opens up possibilities to offer services to many customers, both in manufacturing and in services.

This unbundling of services and connections to other sectors show up in input-output statistics where analysis suggests that the link between services and manufacturing appears to have been strengthened in recent years (Lind 2010). The mutual dependence between sectors has increased, which has been significant for the rapid international growth of Swedish productivity and export capacity.These interconnections (one often speaks of a trade-investment-service nexus) also appear in Swedish export statistics. Service exports have grown faster than manufacturing exports, amounting to 32 percent of total export. An increasing number of services may also be considered tradable (Tillväxtanalys 2010:13).

It is clear that both innovation in service companies and the role of KIBS are important for the competitiveness of the entire Swedish trade and industrial sector. International comparisons also show that Sweden (together with the UK) has one of the most advanced service sectors in the EU (IUC 2011). Sweden shows high comparative advantages (measured with RCA indicators) in data and communication and various producer services (Box 7.2 and Diagram 7.14)

These observations of a close connection between manufacturing and services also imply a more complex innovation dynamics which single static indicators (such as in Chapter 4) do not capture. The close interplay and development of interconnected sector innovation systems between large multinational companies (irrespective of ownership) and a sophisticated KIBS sector in Sweden is likely to be a major driving force for the specialization and renewal shown above.

Diagram 7.14 RCA indicator for different Swedish service categories 1995 and 2008



Source: Tillväxtanalys (2010a) p 16 Note: Definition of RCA see footnote at page 64

Box 7.2 The role of services in the Swedish innovation system

* Producer services account for the largest contribution to productivity growth as well as wholesale and retail.
* The Knowledge Intensive Business Service (KIBS) sector has persistently increased its share of employment, and its level of productivity and growth is above average for the total economy. KIBS' contribution to labor productivity growth is considerable. Within the producer services sector, its contribution makes up the lion's share of the increase in labor productivity growth.
* Service exports have grown faster than commodity trading over the past 15 years.
* The Swedish world market share of services has risen sharply since the late 1990s.
* The number of employees who are, or are potentially, exposed to international trade is larger in the service sector than industry.
* Employment within the exposed service sector has increased over the past 15 years while it has declined within the manufacturing industry.
* Service activities in the production of goods are significant and the service content of export goods is increasing in line with rising income levels in Sweden.
* Service companies which export are more productive than companies who do not engage in export activities.
* Productivity is highest in companies which export both goods and services.
* Investments in intangible assets are becoming increasingly important for productivity development in both manufacturing companies and service companies, where software, design, branding, further training and organizational changes along with R&D contribute significantly to productivity growth.
* Service innovations are, without a doubt, different from innovations in the manufacturing industry, but because many service innovations can now be coded, packaged and distributed by using information technology, services can be standardized and converted into products in a similar manner as within the manufacturing industry, which also creates considerable productivity effects within the service sector.

Source: Tillväxtanalys 2010

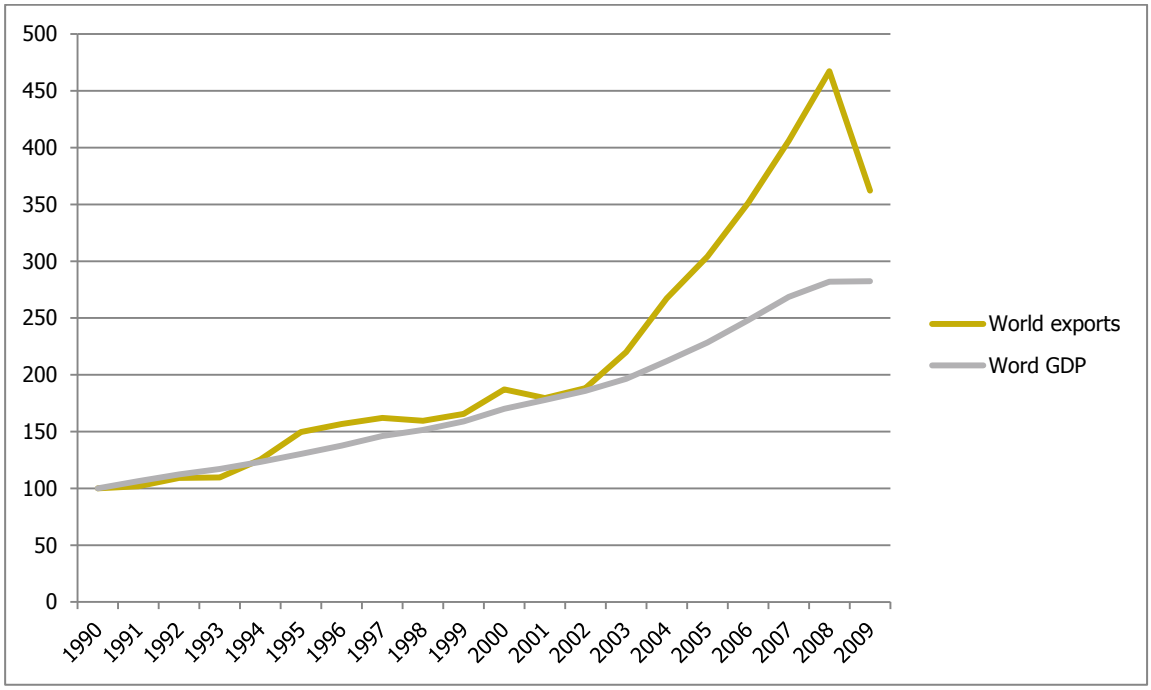
7.3 The increased importance of global value chains in international business[92]

For the last 15 years, the world has witnessed a large increase in the total trade. This increase has been much larger than the total growth in world GDP (Diagram 7.15). A general explanation for this is that trade in intermediary goods and services have

[92] "Global value chain" is not yet a concept with a precise division. In trade literature, the concept of international supply chains is used, which overlaps in part with the GVC concept.

increased. This phenomenon can be exemplified by global value chains for a given product, which can now be divided into discrete steps to a much larger degree than before. The main impetus for this development is development of production techniques and technologies for control of production and logistics by the use of digital technology and communication technology. These discrete divisions of the value chain have transferred the concept of out-sourcing or off-shoring from one organization to another, from one region of the world to another region of the world.

Diagram 7.15 Growth in world exports and GDP, current prices (1990=100)



Source: WTO February 2011 and IMF data on GDP

Although we do not address the issue of global value chains directly in this report of the Swedish NIS, we advocate that there are a number of facts indicating that Sweden has traveled far on the path of outsourcing and off-shoring.

First, the growth of the services sector in Sweden during the last 15 years implies that Sweden has, in comparison to other countries, a larger part of its employed work force in services. Our explanation for this is that large companies in Sweden have outsourced menial activities like cleaning and maintenance as well as advanced services like engineering. Second, the results from the analysis of intangible investments indicate that the manufacturing sector has reduced their material investments, which is in line with the off-shoring hypothesis. However, both the manufacturing and the service sectors have increased their intangible investments considerably since 1995. This is in line with the hypothesis that outsourcing of more advanced services demands further investments, but not of a material kind. Third, service exports have increased in Sweden significantly.

It is reasonable that this dynamics propelling further structural change affect the options on how to design an efficient research and innovation policy mix given the Swedish systemic back drop.

7.4 Conclusions and policy challenges

In this chapter, we have analyzed the performance of companies in the Swedish National Innovations System based on indicators of specialization and renewal. A general conclusion of the evidence put forward is that Sweden has witnessed positive dynamics in both respects. The Swedish NIS has increased its rate of specialization as measured by RCA levels, and continuous renewal in the NIS is propelled both by high R&D levels and other intangible investments and new entrepreneurship. Sweden's performance in this regard is on par with or above the reference group.

The Swedish NIS has also witnessed a large degree of structural change in value chains both within Swedish borders as well as in broad international relationships which show up in close interdependencies between large manufacturing firms and Knowledge Intensive Business Services.

The main cause of worry is the development of R&D. The statistics report a large amount of re-assessment since 2005, which paints a picture of stagnating investments although from high levels. A large part of this change is due to changed strategies in foreign-owned enterprises, which have had to suffer the consequences of decreased R&D available from Swedish affiliates. We do not know whether this is a process which will continue. However, a survey of corporations in 2011 shows that significant further decrease in Swedish-located R&D is not in the pipeline.

The description of the evolution and structure of innovation in Swedish industry in the chapter suggests that the main challenge for innovation policy is perhaps to be less concerned with various aspects of the shape of industry structure (large or small companies, manufacturing vs. services, domestic vs. foreign-owned companies) and more focused on the increasing global dependencies between firms of different sizes, sectors and technologies. If this trend continues, innovation policy should be careful to formulate policies favoring one innovative activity over another. The policy framing might rather focus how to build attractiveness for companies, irrespective of size, sector and ownership, in a rapidly integrated world where research and innovation across technological, organizational and geographical borders is increasingly common. Some important aspects of building this attractiveness are the following:

The development of the knowledge and service economy creates new challenges for innovation strategies and creates a need to broaden existing policy frameworks. Clearly, service companies are not connected to public R&D systems to the same degree as manufacturing (although that is now recognized by major funding agencies). One striking result of various Swedish studies on innovation and productivity is that the innovation premium of being located close to large metropolitan region is high and particularly strong for companies that have a high level of service innovation content (Johansson-Lööf 2011). Again, this challenges existing policy frameworks.

The importance of complex interdependencies in general and the development of service innovation have also triggered a discussion on the role of tax policies for stimulating innovation (IVA 2011). These analyses show that Sweden may have certain tax disadvantages which would hamper the level of risk taking and willingness to supply own financial resources. For instance, innovative companies often rely on various key persons with specific management and technical skills for growth and building

competitive advantage. However, present rules regarding stock options seem to hinder their efficient use as a reward for key persons.[93] The government has increasingly acknowledged various aspects of the connection between taxation and innovative behavior and decided in January 2011 to appoint a broad inquiry into corporate taxation and a review of the taxation of savings in shares and other securities.

Increased interconnectedness also seems to increase the demand for human capital. In general, there is a close link between the ability to export and advanced skill requirements (Syverson 2010). Furthermore, service companies that export are demonstrably highly productive, and companies that export both goods and services have a 15 percent higher labor productivity than companies that export only goods or only services. This might be another indication of the existence of complementarities between goods and services production in the modern knowledge economy. Swedish studies, particularly of various service sub-sectors, point to a close correlation between the level and quality of human capital, productivity and service export intensity (Elisasson et al. 2010). For instance, service sectors with a high degree of employees with higher education tend to have higher export intensity. Companies with a high degree of service exports tend to have a higher level of employees with a higher education degree compared to companies that do not export and companies exporting manufacturing goods.

Globalization of research and innovation is transforming the world economy to a globally interconnected system step-by-step, and this is seen in the much more complex patterns of innovation described in the chapter. A concern put forward regarding international firms is the localization of strategic parts of the enterprise. It will therefore be important to seek solutions within the framework discussed above rather than relying on solutions that fit past debates or old data. Awareness of this is an important starting point for the future direction and design of Swedish innovation policy.

[93] In Sweden stock options are taxed as income from labor instead of as income form capital. For the relevant remuneration here we talk about with marginal tax rates above 50%

8. Summary and further analysis

The report has analyzed the performance, identified some weaknesses and elaborated on various possible policy challenges of the Swedish National Innovation System. It is to be used as a background analysis for an upcoming evaluation by the OECD of Swedish innovation policy, which is to be finished by June 2012. The writing of this report was conducted during July and August 2011 and follows the structure of the terms of reference suggested by the Ministry of Enterprise, Energy and Communications and the OECD. Given the time frame allotted, a full description of all relations and actors in the innovation system has not been possible. Rather, this study has focused on identifying where Sweden's performance is weaker than relevant comparison countries in the reference group (CH, DE, A, NL, SF, DK, UK) and elaborating on some of the possible causes behind the observed developments in more detail.

The purpose of the report is to provide an analysis, given various comparative indicators, of Sweden's performance compared to these advanced, high-income countries and to identify strengths and weaknesses in the innovation system. Moreover, one ambition of this study is to point to issues where more evidence and analysis is needed in the upcoming evaluation in order to be able to assess future policy challenges and policy ambitions.

The analysis uses comparable innovation indicators complemented by more specific national statistics on different aspects of and actors in national innovation systems. The overall observations, based on EU and national indicators, of the performance of the Swedish innovation system are summarized below:

- Sweden has, together with Finland, the highest average growth in labor productivity between 1995 and 2007.
- Sweden and Finland show the largest increases in total factor productivity between 2001 and 2007.
- Sweden scores second behind Switzerland in overall innovation performance and shows a slight decrease between 2006 and 2010.
- Sweden has increased its level of export of high quality products to international markets during the last 10 years.
- Sweden ranks highly in indicators measuring Human resources, Finance and support, Firm investments, Linkages and entrepreneurship and Intellectual assets.
- Sweden ranks lower in indicators measuring Innovators and Economic effects as well as in the dimension of Research systems.
- The Innovation Scoreboard Indicator shows a weakened performance in the indicator that refers to certain aspects of innovation capacity among SMEs and the ability to create excellence in the research system and attractiveness for foreign talent.
- Sweden has a lower degree of specialization levels compared to many of the reference countries measured with RCA indices, and a high concentration of a

limited number of products. However Sweden has increased the number of sectors with RCA above 1 more than the reference countries.

- Sweden is not an extreme case of highly concentrated R&D expenditures compared to other advanced countries.
- The data on R&D expenditures show that Swedish investment has decreased compared to other countries.
- Sweden has a lower percentage of highly-cited research compared to some of the reference countries.
- There is no evidence that Swedish entrepreneurship is lagging behind that of other advanced countries.

An overall conclusion from the analysis of available indicators is that these statistics must be used with some caution. It is important when evaluating the quality of a nation's innovative performance to put available indicators into specific contexts. First, even if the supply and quality of indicators have increased for policy analysis, they still lack in precision and validity for making broad claims about the innovative performance of companies and nations. A closer look of the statistics behind the composite indexes, we draw the conclusion that the variation between the selected countries among several statistical indicators is too great to conclude that Sweden has a systematically weaker output than the rest of the countries. It seems that the composite indexes conceal this kind of uncertainty.

Therefore these indicators must be complemented and compared with other statistics in order to be legitimate. Second, overall the presented indicators suggest that there is no evidence of an overall poor Swedish performance regarding output when Sweden is compared with seven similar countries. On the contrary, the analysis points to the development of much more complex innovation patterns in the Sweden, and three overall themes have emerged which require further attention in the evaluation and in future policy analysis.

Firstly, we interpret evidence from different statistical sources that the adaptation and performance of the Swedish NIS has been quite successful the last 15 years. The allegations of a Swedish "paradox" seem to be based on either large (linear) expectations of the growth effects on the level of certain input factors, such as R&D, or an uncritical use of comparative innovation indicators, which still have unclear linkages to overall business performance.[94]

Secondly, Sweden has weaknesses in the performance and organization of the indicators measuring aspects of the research system. The report identifies and discusses some missing conditions for effective governance of innovation policy in Sweden. In addition, some issues are raised about the performance of Swedish universities in generating highly-cited research and in finding effective national and international collaboration models with industry.

Thirdly, the analysis in the report suggests the development of much more complex innovation patterns in Sweden, which are hidden in the structure of available and static

[94] Ejermo & Kander (2006) discuss this in more detail.

innovation indicators. Evidence shows that Sweden's NIS has been reorganized in complex value chains which imply that common propositions like: "large corporations do not contribute in the same amount as earlier" or "Sweden lacks in high technology exports" are not entirely true or at least reflect misconceptions about the structure and importance of value chains in the NIS as well as the increasing dependence between advanced manufacturing and knowledge-intensive business services. These complex and interconnected innovation systems where R&D-intensive manufacturing and knowledge-intensive business services meet seem to be areas where Sweden has competitive advantages.

Fourthly, the abundance of combining new "innovation" indicators provides opportunities to detect areas where Sweden needs to reflect on how to develop attractiveness for investments in research and innovation and where the weak links are. Our method of focusing on a small sample of reference countries suggests from whom we can learn. The conclusions are that from Denmark, Sweden can learn how to develop policies which spur entrepreneurship. From Switzerland, Netherlands and Denmark, Sweden can be inspired to better develop our universities.

These and other observations in the report suggest that assessing the innovative performance of small, rich open national innovation systems will require a careful analysis of how interdependencies have grown and what this may mean for policy focus, design of innovation policy and multi-level governance when knowledge increasingly flows over technological, organization and geographical borders. The report provides various suggestions as to how that can be done.

In conclusion, the new and changing contexts of research and innovation those companies in small countries face must be acknowledged by policy makers. The increased importance of building attractiveness for research and human capital for existing and new companies, irrespective of ownership, sectors and size cannot be ignored or denied. It does not necessarily always imply an increase in R&D since so much of the new knowledge economy rests on service innovations with a different logic for value creation. Thus, government and firms must find new ways to increase their absorptive capacity in order to acquire knowledge developed elsewhere. In this new context, the challenge is to find the sweet spot in the global value chain. This would imply that sectors are becoming of less importance than where firms in different regions locate the value network that matters for innovation and productivity development in Sweden.

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