Sweden at the Innovation Frontier – Assessing Performance and Challenges in a Disruptive World

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Abstract

The paper assesses the innovative performance and challenges that a small innovative country like Sweden faces in an era of intense global competition. We contrast innovative performance with similar countries in Europe as well as discus the reliability and validity of indicators used to shape policy development. The conclusion from the analysis shows that available input-output indicators must be used with some caution. Even if the supply and quality of indicators has increased for policy analysis, they still lack precision and validity to make broad claims about the innovative performance of companies and nations. It is argued that understanding knowledge flows (rather than simple input-output metrics) are a key to understand innovation processes for small countries at the innovation frontier; subsequently, small countries will have to abandon failed policy orthodoxies in order to cope with future policy challenges.

Keywords
Innovation, indicators, innovation policy

1. INTRODUCTION

An important concern for many small advanced and open economies is how wealthy nations can stay successful in a rapidly changing global knowledge economy. The first step to answer this question is to create an adequate description of past performance and a diagnosis of current problems based upon a multitude of available indices and indicators. This study assessed the innovative performance and challenges that a small innovative country like Sweden faces in an era of intense global competition. It does so by contrasting the innovative performance of Sweden with similar countries in Europe as well as discusses the reliability and validity of indicators used to shape pol-

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icy development. We argue that understanding knowledge flows (rather than simple input-output metrics) are essential to understand innovation processes for small countries. Small countries have to abandon some failed policy orthodoxies, review their current beliefs, and modify their current conceptual analysis in order to cope with future policy challenges.

1.1. Why Sweden?

Sweden is among the top countries in almost all major innovation and competiveness league-tables. Sweden and some other Nordic countries have had a 15-year period of favorable economic growth and have managed to successfully cope with the present financial crisis. The various factors behind the successful 'Nordic Way' have been a salient theme in academic and policy circles (Eklund, Berggren, Trädgårdh, Persson, & Hedwall, 2010). Further, small advanced countries (less than 20 million people) have grown faster (albeit with significant differences among these small countries) in the last two decades than other large developed countries; small countries have outperformed larger countries in a unique historical context (Alesina & Spolaore, 2003).

Sweden now stands as a top-performer in growth, competiveness, and innovation league-tables, which is in contrast to the two decades of slow growth in the 1970s and 1980s.

Past success is no guarantee for continued high economic performance. Small countries face many internal challenges such as unfavorable demographic development, rising demands for welfare services, and intense global competition from emerging countries. These countries have successfully adapted to a changing global environment; however, they also face new challenges from firms and policymakers. This has generated structural pressures and policy changes to restore and increase national competiveness in order to restore the social contract; subsequently, innovation is high on the policy agenda. It is against this background that Swedish performance and positioning of innovative performance will be critically assessed: 1) What type of evidence drives the innovation policy debate in Sweden and to what extent do it fit with a critical analysis of the actual performance? 2) What challenges does a small country in the innovation frontier face and how can that be described? 3) Has research and innovation policy adapted to these challenges?

The goal is to re-frame and re-interpret some aspects of the innovative performance of the Swedish Economy that may influence other small innovative countries or in countries where innovation is a policy objective priority. One immediate problem is that there exist no self-evident indicators that tell the policy maker when enough knowledge has been gathered to undertake policy actions. The risk is that policy is driven by orthodox beliefs and myths where the use of one-dimensional indicators increases the frequency of failure and unintended consequences; particularly in an era of large structural change.

The Swedish policy debate has been driven by two perceived problems. First, the strength of the Swedish NIS has been questioned by critics that claim that Sweden has high knowledge input values but struggles to convert this into innovation (The Swedish Paradox). The evidence for low output is based on three observations: 1) Low exports of high technology goods (Edquist & 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 Innovation surveys in the late 1990s (Bitard, Edquist, Hommen, & Rickne, 2008). Bitard et al. (2008) conjecture (based on CIS data) that Sweden-based MNC was an especially poor innovator from a comparative perspective. Second, a perceived Swedish policy problem has been an overly large dependence on large footloose multinationals and a lack of entrepreneurship that creates vulnerability in future innovative performance. We argue that present indicators and their use in policy have underestimated and masked the inherent dynamic features in a small innovative economy (such as Sweden).

The outline of the report is as follows: The following sections describe the analytical and statistical framework and provide a short description of the development of Sweden using various macro indicators. Sector 2 uses existing comparative indicators to discuss where Sweden seems to have advantages and problems as well as discussing the reliability and validity of these indicators. Section 3, Section 4 and Section 5 provide alternative descriptions of Sweden's performance and challenges. Section 6 discusses the extent to which innovation policy has adapted to new challenges. The conclusions are provided in Section 7.

1.2. Framework and Method of Analysis

The study of growth performance and innovation is intense. Endogenous growth theory is important to understand the different growth trajectories of countries that focus on the quality and growth of R&D but less on how it is to be exploited (Carlsson, Acs, Audretsch, & Braunerhjelm, 2007). Evolutionary inspired research efforts have focused on micro incentives that govern the accumulation and exploitation of new knowledge manifested in the entry and exit of new firms and innovations. National innovation system literature is a particular branch of evolutionary research that has contributed to depictions of the various actors important for a high innovative output; however, it is ambiguous about how the drivers, incentives, and conditions shape the exploitation of current and new knowledge. The research suggests that a systems view on various microeconomic drivers, incentives that influence the creation (as well as exploitation and diffusion) of new knowledge and the important interconnectedness between the two is important to analyze innovative performance. The different chapters and the statistical analyses are largely structured around these two overall dimensions. The innovative performance of a country depends on the performance of a national innovation system; however, it does so in a revolutionary international context of knowledge production and organization (Globaliseringsrådet, 2009). During the 20th century, most knowledge generation and production were made by developed countries; however, most new rapid knowledge investments have taken place in emerging countries since the early 1990s (UNESCO, 2011). Emerging countries still lag behind developed countries; however, these and other globalization forces are strong enough to challenge the established concepts of goals, direction, governance of research, and innovation policy. In addition, two long-term shifts in the methods that companies use to create value and generate productivity are underway (Zyman & Breznits, 2010). First, production is (to a great extent) conducted in discrete stages and in specific geographical environments around the globe. Companies, nations and regions tend to specialize on specific stages in global value chains (GVC). Second, this development has been influenced by the application of ICT tools in manufac-

turing and services that have driven a second shift in value creation. Service innovation and service activities have been transformed into formalized, codified, and information-based processes that have transformed how value is created in services and in manufacturing. Closed innovations systems are replaced by open innovation features such as outsourcing, off shoring, and strategic R&D alliances that suggest an increased importance of knowledge flows between technological, organizational, and geographical borders (Karlsson, Johansson, & Norman, 2011).

These challenges and changes create important issues on how to analyze the performance and prospects of small high-income countries. It raises questions about the resulting policy choices that accompany the changing logic of value creation and the indicators used in a highly interconnected world. Additionally, a comparative analysis of innovation systems is usually conducted to compare a single country with a median or average of all other OECD countries. Here we advocate a comparative strategy where a specific NIS is assessed with other NIS from similar contexts and starting from macro indicators over comparative indices and to indicators that measure knowledge flows. Given the importance of a system perspective and path dependencies in small countries we argue the following conditions as important in order to assess the Swedish NIS[1].

- High tax rates and large public commitment: Sweden's 45% GDP tax rate is second only to Denmark among the OECD countries.

- A relatively small domestic market and high international dependency

- The sum of exports and imports consists of a large variety of products. Sweden's international trade amounts to more than 50% of GDP. Therefore, it is reasonable to assume that globalization has a greater influence on a country with a high trade intensity and countries with trade patterns (similar to Sweden's) ought to have similar future challenges.

- Influence from international businesses/corporations: These corporations continuously evaluate the pros and cons of off-shoring key functions and processes that affect the Swedish NIS.

- R&D as an important characteristic for private sector competitiveness: Sweden has one of the highest R&D intensities in the world and an NIS similar to the Swedish can expect the same global challenges and opportunities.

The short list of countries that fit this list consists of:[2]

[1] This follows the argument in the matching on observables discussion in quantitative evaluation.

[2] The 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. Therefore, we do not consider the early 1990s as a relevant time period for assessing the performance of the Swedish NIS.

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

Germany, (a large country) is one of Sweden's largest trading partners; it imports as well as exports and frequently competes in the same markets

United Kingdom, (a large country) is one of Sweden's largest trading partners (like Germany) and has a well-developed service sector

Netherlands, has a large company profile and a size that makes it interesting to compare with[3]

Switzerland, (a small country) has high R&D levels and is dependent on large corporations

Austria, (a small country) has high research and innovation policy ambitions

These countries are often close to Sweden on many assessments of growth and innovation. They are of special interest in regards to their high performance as well as for the structural characteristics that we believe are important to consider when framing and assessing the performance of the Swedish NIS (Lundvall & Borrás, 2005, p. 614). These countries face similar global challenges in a world where trade has increased in volume and where ICT development has fostered an internationalization of supply chains developments. Of special interest is that the selected group of countries is those that were partly sheltered from the first wave of globalization; however, they are increasingly exposed to globalization and increased competition in research and innovation from emerging countries that acquire more sophisticated means of production (Rae & Sollie, 2007).

1.3. A First Look at Indicators

Innovation is about creating values; therefore, changes in GDP are a natural but incomplete starting point as an overall measure. Diagram 1.1 illustrates these levels for Sweden and the selected countries of comparison from 1989-2010[4].

Sweden ranked for the fifth place at the beginning of 1989 and improved to the third place by the

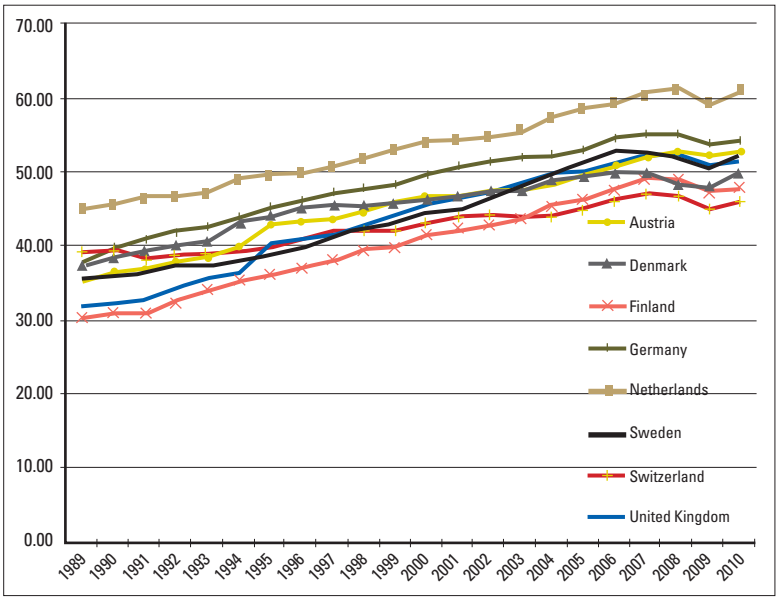
[3] Netherlands large transit trade complicates the comparison however.

[4] The general level of GDP depends on the number of working hours and the utilization of the available workforce that 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 provides information about the actual efficiency of the labor utilized, which provides a relevant benchmark to follow and compare how the system actually delivers va*lue.*

end of 2010. Switzerland scored lowest in the group for 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 increased for the first time after several years of stagnation. 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.

Diagram 1.2 covers four international economic crises from 1989 to 2010 (the real rate of interest crisis in the early 1990s, the 1997 Asian Financial Crisis, the 2001 Dotcom Crisis, and the 2008 Financial Crisis partially due to subprime market defaults in the US) and large dynamic changes stemming from increased international trade and the diffusion of digital technology applications. Sweden made large institutional changes due to the crisis in the early 1990s and it is of special interest of how Sweden performed excluding those years[5]. Thus, Diagram 1.2 shows that Sweden and Finland have the highest average growth in labor productivity in the middle period of 1995-2007 and suggests 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 at the beginning of the decade. The decision to let the currency float also spurred exports and led to less relative unit costs.

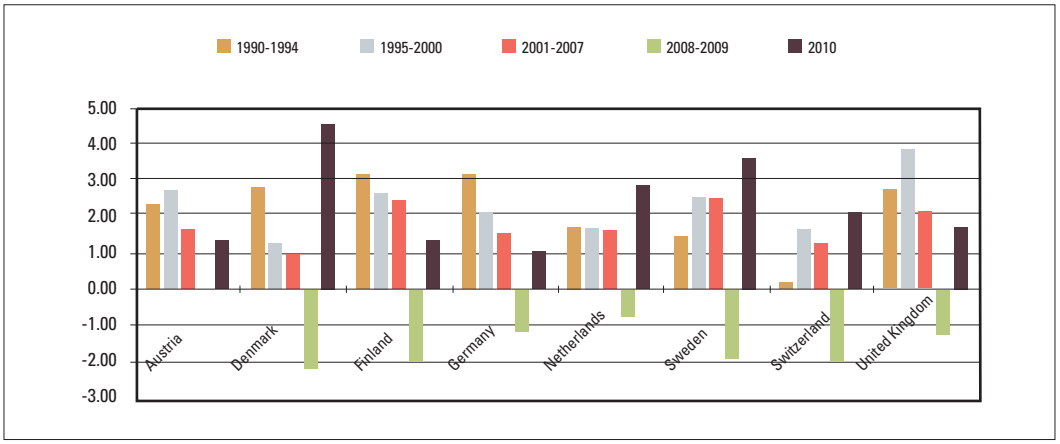
DIAGRAM 1.1. GDP per hour in 2010 price levels PPP according to EKS method



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

[5] This crise started in Sweden with the bankruptcy of real estate company Nyckeln august 1990 and continued to 1993.The crise resulted in a Swedish GDP decrease with 5%. See Jonung et al 2009

DIAGRAM 1.2. 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/

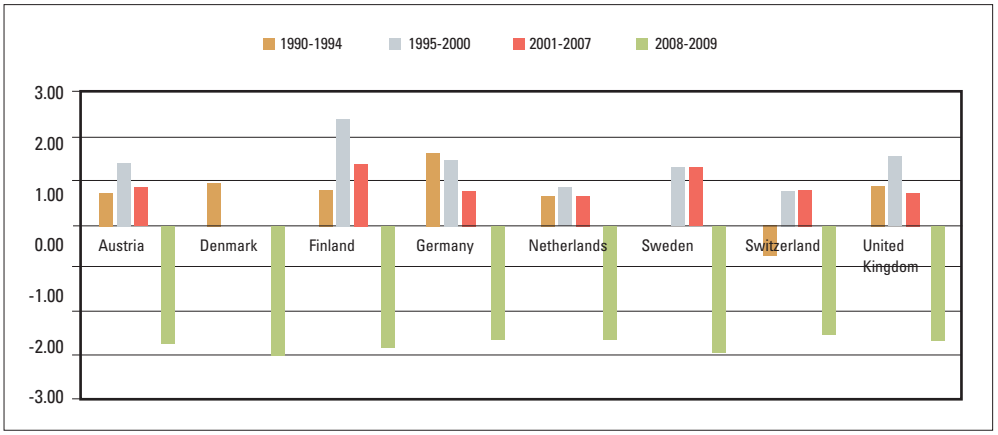
[5] Diagram 1.3. divides the period 1990-2009 into four separate periods that contain total factor productivity indicators. It shows that the Swedish TFP performance in 2001-2007 is second only to Finland. During the first period (1990-1994), Sweden suffered from the crisis in the banking sector, general rises in costs and the real rate of interest crisis common throughout Europe with a low aggregate demand that was partly spurred by the German unification process[6]. Together with Switzerland, Sweden's TFP rates were the lowest in this period; however, on par with Austria, Germany, and the UK. Finland excelled in TFP growth rates during this period. Denmark's TFP rate is noteworthy for its underperformance since 1995[7].

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

[6] The real rates of interest started to increase in Europe in the late 1980 due to tax reforms, the Gulf war and the German unification process. See Jonung et al (2009)

[7] The main explanation for this is probably that the growth in global demand has not favored Denmark's industry specializations (especially in food and agriculture).

DIAGRAM 1.3. Development in TFP for Sweden and comparison group of seven countries, 1990 to 2010.



Source: Total economy database, Conference Board

Sweden gained when ranking is measured in growth of GDP per hour. More importantly, Sweden's large TFP growth over the last ten years suggests a high level of innovative activity. The following section offers a thorough assessment of the Swedish innovative performance conducted with indicators produced in the Innovation Union Scoreboard (IUS) framework.

2. SWEDISH RESEARCH AND INNOVATION AS SEEN IN THE IUS INDICATORS

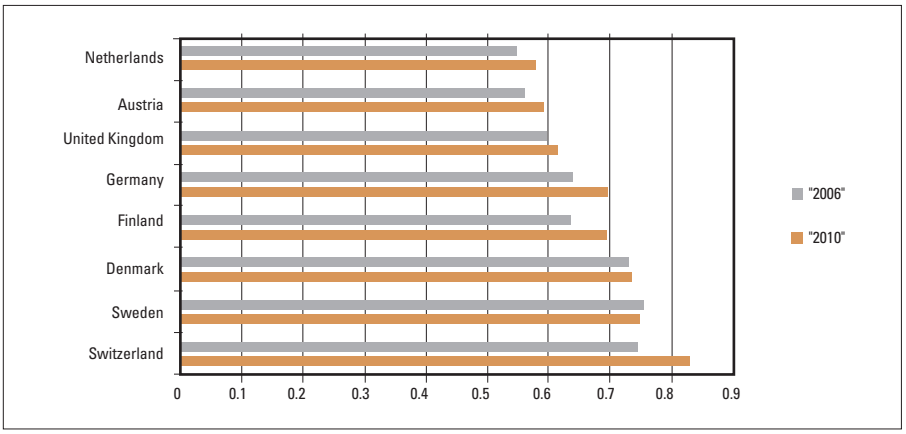
The Innovation Union Scoreboard (IUS) indicators can be used on an aggregate level to provide a first picture diagnose of Sweden's strengths and weaknesses as well as to critically assess the reliability and validity of these indicators that frame the challenges and opportunities for small wealthy economies[8].

According to the composite index (Figure 2.1), Sweden has (in contrast to its competitors) not improved in the value of the Summary Innovation Index (a fact that has triggered significant concern in the policy debate). However, rankings are known to exaggerate real differences between countries[9]. We use the information within the IUS system of indicators to understand the areas where Sweden seems to require more attention.

[8] The Innovation Union Scoreboard is meant to help monitor the implementation of the Europe 2020 Innovation Union flagship by providing a comparative assessment of the innovation performance of the EU27 Member States and the relative strengths and weaknesses of their research and innovation systems

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

DIAGRAM 2.1. Change in Summary Innovation Index according to Innovation Scoreboard



Source: ProInno Metrics IUS database 2010

Diagrams 2.2 through 2.9 illustrate a disaggregation of the index into various sub-composite indices[10]. 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. In two indicators, Sweden shows a positive development but is overshadowed by other countries that 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 overall change in the various countries. The conclusion is that in indicator areas where Sweden's performance is 'best' there are indications of other structurally similar countries 'catching up'.

Sweden has decreased its performance in four indicator areas. Two of these areas are previously mentioned and the other two are *Innovators (Diagram 2.8)* and *Economic Effects (Diagram 2.9)*. 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 rankings since 2006. Sweden's ranking has dropped from fourth to sixth position.

In the dimension *Research Systems* (Diagram 2.3), Sweden (along with its competitors) exhibited an increase in values since 2006. The UK and the Netherlands have had a larger relative increase in this dimension that has resulted in a decrease in Sweden's rank in 2010. Changing the focus from Sweden to the other countries, it is notable that Switzerland ranks highest (or in the top three) in all

[10] 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; however, in order to state the relative performance of the Swedish NIS, the scoreboard produced by the European Union is a relevant point of departure.

innovation dimensions except *Finance and Support and Linkages and Entrepreneurship*. Also of importance is that the low performance of Germany in the *Enablers,* mediocre performance *in Firm Activities*, and strong performance in the *Output* group is second only to Switzerland.

This first overview of the various composite indicators suggests that a more detailed analysis is needed to determine why Sweden seems to be having difficulties staying ahead. Thus, we look closer at what the statistics behind the dimensions *Innovators, Economic Effects* and *Research Systems* actually mean and examine if the conclusions from the composite indicators of the dimensions are valid.

The analysis of the IUS-data adds to the perception that Sweden has an input advantage but a lack of efficiency to exploit this advantage in economic output. This is partly due to a decrease in the values of the following three indicators:
• The share of revenue streams from new to market and new to firm products and processes
• The export of revenues from knowledge intensive services
• The revenue share of medium and high tech exports

However, there are a number of drawbacks in the reliability and validity of these indicators that cast some doubts on the general conclusions about 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 to show that 'high quality' Swedish products represent a large share of the total exports. The export share of knowledge intensive services need more research to understand how it is aligned with other indications of successful exports in services like computer and information services (see Section 3 and Section 4).

Regarding the *Innovator dimension*, we conclude that this indicator is solely based on the statistical measure of the share of SME innovators. This measure is based on the CIS-survey where random errors are known to be large (Hall, 2011)[11]. At present, we do not know if the exhibited change over time between countries is significant. The reliability in the indicator is thoroughly investigated more in Chapter 3 and Chapter 4; in addition, recent national and international data is used to analyze Swedish performance in this dimension. The dimension *Research Systems* suggest that Sweden lags in improvement in the quality of research; subsequently, this is closely examined Chapter 3.

We have considered seven of the IUS indicators in the output group in detail that consist of the innovation dimensions of *Innovators* and *Economic Effects* where Sweden (according to the composite index) was found with a weak performance. However, this is contrasted with very good performance in the macro indicators on productivity to confirm that there is very little relationship between the various innovation and competitiveness rankings and growth prospects(Berger & Bris-

[11] In reports on innovations surveys standard errors of proportions are in general not reported. Changes between countries and between years can be insignificant due to sampling error or random error

tow, 2009). In addition, analyzing the statistics behind the composite index, we draw the conclusion that the variation between the selected countries among several indicators is too significant to conclude that Sweden has a systematically weaker output than the rest of the countries. Thus, it seems that the composite index conceals various aspects of performance and provides mixed indicators. The following two sections thoroughly assess the relation between the generation and exploitation of knowledge.

Diagram 2.2. Human Resources (Enabler)

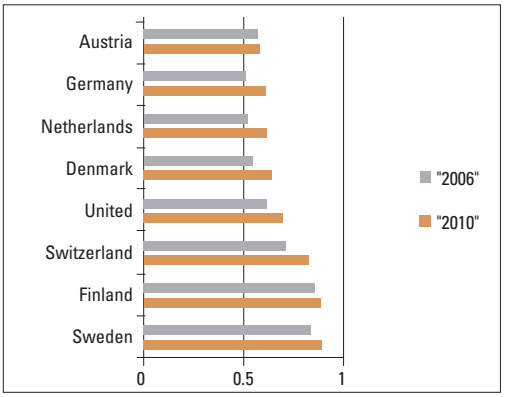


Diagram 2.3. Research Systems (Enabler)

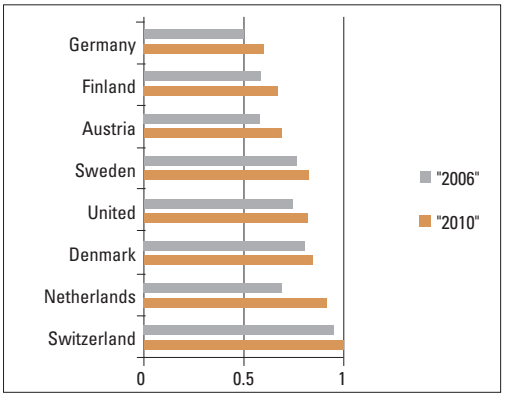


Diagram 2.4. Finance and support (Enabler)

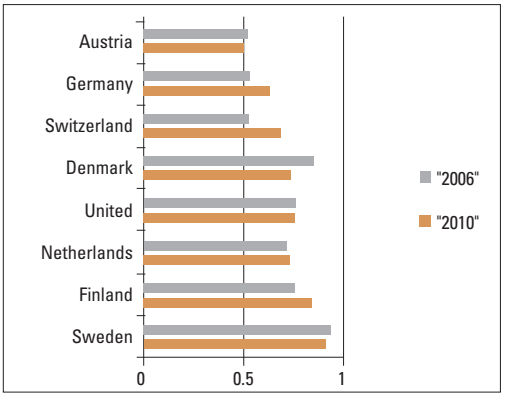


Diagram 2.5. Firm investments (Firm activities)

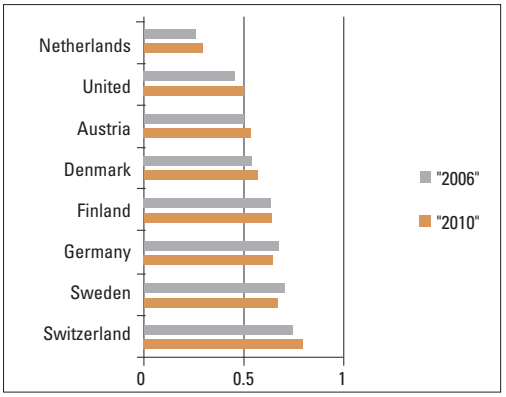


Diagram 2.6. Linkages and Entrepreneurship

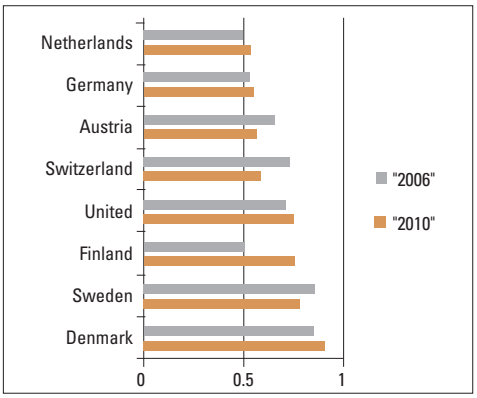


Diagram 2.7 Intellectual assets (Firm activities)

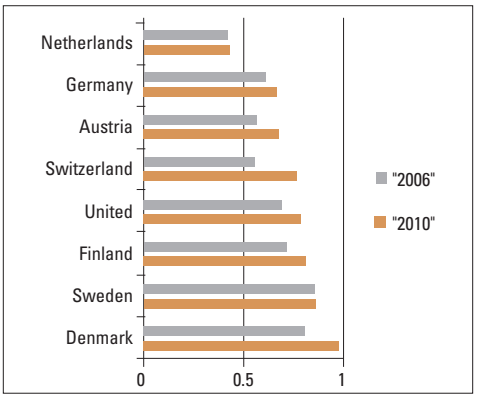


Diagram 2.8. Innovators (Outputs)

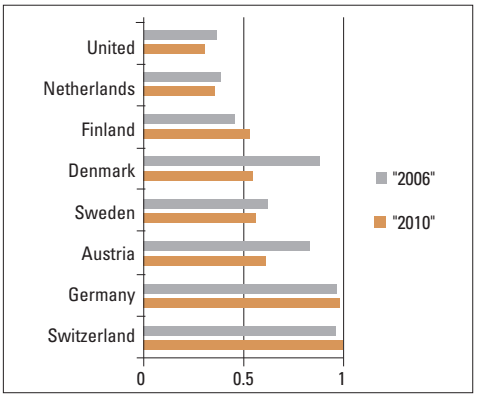
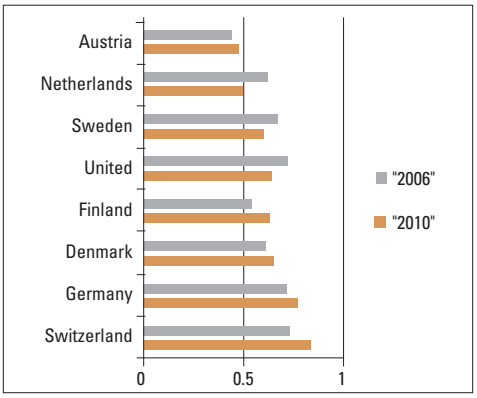


Diagram 2.9. Economic Effects (Outputs)



Source: ProInno Metrics IUS database 2010

3. PUBLIC AND PRIVATE R&D INPUT – FROM BAD TO GOOD TO A PROBLEM

3.1. Knowledge Base – Public Research

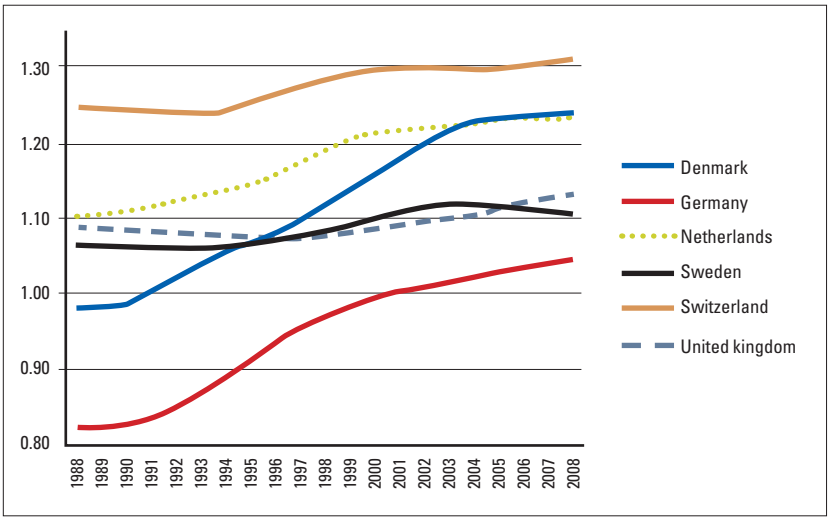
Compared to many other small countries, public research in Sweden is mainly carried out at universities. The research institute sector is small and only accounts for 4% of total public research; subsequently, the amount, quality, and governance of university knowledge creation is a crucial component to assess[12].

[12] Statistics Sweden UF10SM1201 Table 8

Universities are exposed to several global pressures. There is an intense search for excellence measured by the high output of scientific articles and frequent citations; however, they are expected to deliver useful knowledge to firms and organizations. Thus, there have been a series of ongoing reforms in many countries to improve excellence and usefulness (McKelvey & Holmén, 2009).
Scientific quality is one of several factors to stimulate innovative economic output; however, not all companies demand high caliber research. Research has shown that scientific quality and access to a highly-skilled labor force is an important attractor for the location of corporate R&D; factors that have become more important for location decisions in an increasingly global knowledge market (Broström & McKelvey, 2009).

Given the methodological problems entailed in the determination of the best method to measure quality, recent evidence of international citations data indicates that Sweden is losing scientific competiveness compared to a number of countries (Vetenskapsrådet, 2010). Diagram 3.1 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) with a total 10% advantage over the average citation frequency. Other countries have had a more pronounced positive development (although Germany is on a lower level than Sweden).

Diagram 3.1. Field-adjusted citations 1988-2008



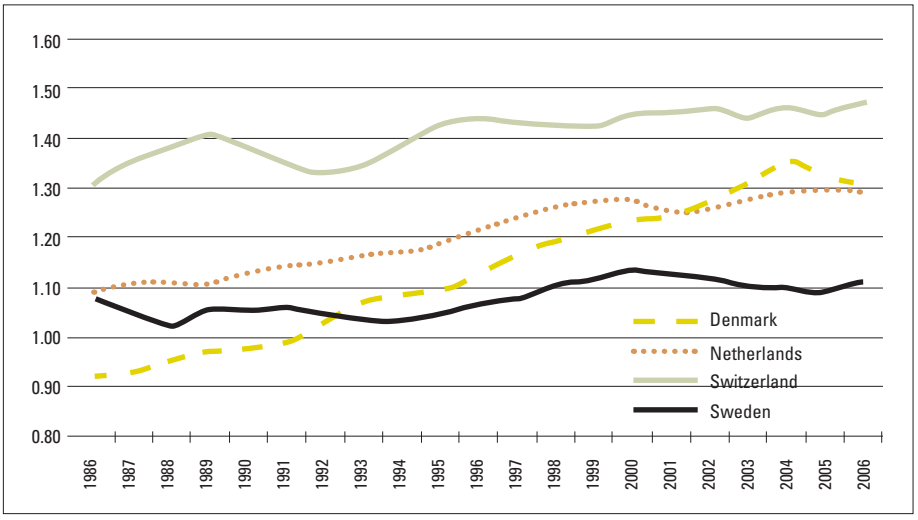
Source: Vetenskapsrådet (2010) Not: Avskuren y-axel i syfte att tydliggöra utvecklingsfasen

In Diagram 3.2, we focus on quality publications and illustrate the frequency of Swedish publications among the 10% most cited publications. The evidence indicates that Sweden has a relatively low proportion of highly-cited publications compared to a number of other competitors in the global research arena. European reference countries have increased their citation rates; however,

Swedish publications are cited at a high and 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. Sweden also seems to have a low proportion of citations when all the authors have a Swedish address compared to other reference countries; subsequently, this may indicate a lower degree of high caliber international collaboration (Vetenskapsrådet, 2010).

The report by the Swedish Research Agency explains some of the 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 to a low proportion of highly-cited publications in Swedish research performance.

Diagram 3.2. Field-adjusted citation frequency in relation to the top 10% of most cited publications



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

Other studies compare the performance of Nordic universities at the single university level by looking at publication and citation levels as well as rates of growth. The Swedish indicators are significant in a number of respects as summarized below (NordForsk, 2011):

- Denmark stands out among Nordic countries with a substantially higher citation impact and publication growth.
- Sweden has the greatest publication activity among Nordic countries but slow growth (Health and Biomedicine accounts for 51% 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 shows that Sweden has lost its longstanding edge in clinical research. This can be partly explained by the deteriorating funding to this area and partly by a marked slowdown in the willingness among medical doctors to pursue graduate studies in clinical areas (SOU, 2009).
- Stockholm University is one of the most highly-cited Nordic universities; however, few Swedish

universities have citations among the top 10%. In this respect, the Danish (and the Swiss) have more universities among the top 10%.

The declining scientific quality has been discussed from different angles in the Swedish university performance debate and a number of hypotheses have been argued to explain the change. Research has shown that the disbursement of funding and the autonomy of universities is crucially important to explain the differences in university performance between US and European universities; therefore, evidence is presented below to compare the performance of universities in different countries (Aghion, Dewatripont, Hoxby, Mas-Colel, & Sapir, 2007; Himanen, Auranen. Puuska, & Nieminen, 2009).

Table 3.1 presents relative country performance in 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 (*Ibid.* Aghion, et al., 2007). For each country, the sum of the top 50 rankings are computed and divided by population and then the country score is divided by the US score. Thus for each column the number relates to the US=100 score. Table 3.1. indicates that US performance completely dominates all European countries in the column for the scores of the top 50 universities; in addition, only Swiss and UK universities rival American universities in the top 50 universities.

Among the European countries, Swedish, Swiss, and UK universities dominate the top tier, where Swedish universities do particularly well in the top 100 but not as well as Swiss, UK, Dutch, and Canadian universities among the top 50 universities. Swedish universities (using other indicators than citations) seem to have many universities with good scientific quality but few that belong to the top international level.

TABLE 3.1. Shanghai Ranking of universities, Country performance index (US 100)

Country/State	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 other European countries. The current evidence shows that Swedish universities have considerable per-student budgets and more

wage setting and hiring autonomy compared to other European countries. A distinctive feature of Swedish research is that a significant part (measured in years) is conducted by graduate students (Deiaco, Gierz, & Reitberger, 2002). The one indicator where Sweden stands out is in faculty with a 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 (Aghion, et al., 2007). The evidence indicates that less than a quarter of those employed with a doctorate degree at Swedish universities has their degree from another university (Reitberger & Sittenfeld, 2011).

These international indicators point to some of the challenges for Swedish universities in the global race for prestige and highly-cited articles. Swedish research tends to focus on various deficiencies in the levels and structure of research funding. Public R&D did not increase during the early years of the new millennium and the Research and Innovation Bill of 2008 adjusted for this slowdown; however, many researchers have indicated that 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 the rates of investment by other countries .

The Swedish university system has undergone considerable changes in the last twenty years. External funding has considerably increased total university funding. In addition, Sweden has some 39 higher public education institutions. During the last ten years, former university colleges have received full status as universities. These two trends have resulted in a polarization of resources in the Swedish university sector (Ljungberg, Johansson, & McKelvey, 2009). As an example of this polarization, smaller universities and university colleges generally report a significant volume of research subjects relative to their size (and sometimes equal to larger universities), but they do not have many researchers. The figures can therefore be interpreted that many of the research subjects in these new HEIs are empty and lack a critical mass to some extent that may lead to a lack of competitive and international specializations.

The observations do indicate a quality problem on the input side of public investments. The rather poor development of high-level Swedish research quality is not yet fully understood and suggests a need for a more-thorough analysis of the factors that determine the performance of high caliber and dynamic research environments. International research indicates that the factors behind decreasing quality are found in the level of funding as well as in how funding and various organizational factors contribute to a dynamic research environment (Heinze et al., 2007). International evidence suggests that competitive recruiting on a national and international scale seems to be particularly important; however, Swedish universities have a higher proportion of in-house recruited faculty 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 for research group members.

3.2. Knowledge Base - Private R&D

R&D as an input factor receives significant attention in innovation analysis; however, we know very little about how R&D expenditures relate to domestic growth. Sweden's high R&D intensity primarily comes from market-based decisions in a limited number of large corporations. According to the Swedish R&D survey, enterprises with 250 employees (or more) accounted for over 80% of total R&D expenditures in the enterprise sector.

The concentration of R&D to large companies has been seen as a major weakness in the Swedish national innovation system. However, Sweden is not an extreme case of highly concentrated R&D expenditure when compared to other European countries and our selected reference group (Table 3.2). As for the largest corporations, the Swedish fraction is above 80%, which is high but not the highest (far right column). It is slightly higher in Germany, the UK and Finland. Column 4 shows the proportion of the five largest enterprises with respect to R&D in relation to total R&D among all enterprises traded in public stock exchanges and Sweden once again has a high concentration (albeit not unique) among other small countries.

TABLE 3.2. R&D in relation to GDP, distribution of in enterprise sector 2007, percent

	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	

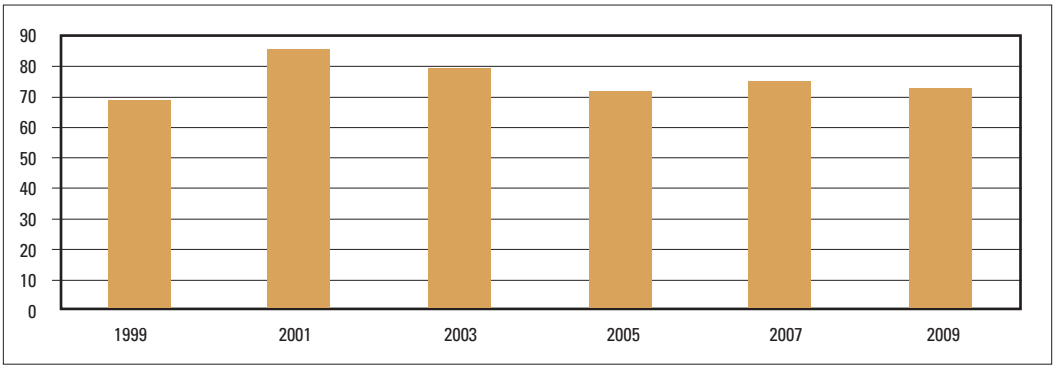
*Source: Swedish Government (2011a), primary source *Entreprenörskapsforum (2010, p. 111)*

R&D in the private sector is an important indicator of innovative capacity and the pattern in Sweden over the last ten years needs further attention (Diagram 3.3). Sweden is often recognized as having large private R&D investment but development over the last ten years can be interpreted as no significant change in R&D levels. In fixed prices, the 2009 level is SEK 5b above the level of 1999 (an average annual increase of less than 1%). The estimated values for 2010 indicate a further decrease. Comparing with the pre-crisis year of 2007, the decrease is even larger, SEK 7b.[13] Depending on how we interpret the 2001 level, we get two discomforting and alternate stories; that there seems to

[13] It should be noted that the figure for 2001 has been considered as inflated by extreme usage of external consultancy in R&D enterprises (mainly Ericsson).

be a decrease in R&D investment or that there seems to be no increase in R&D investment.

DIAGRAM 3.3. Total R&D expenditures for enterprises of 50 employees (or more), billion SEK 2009 prices



Source: Statistics Sweden

What dynamics have governed this development? Before 2007, the increases in R&D mainly occurred in the service sector; however, the R&D in the service sector decreased the most between 2007 and 2009. Decomposing 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 3.3). As for size groupings, the smallest firms are the ones with the largest relative and absolute decreases; however, 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%, while the manufacturing sector increased theirs by 5%.

A significant part of the high Swedish R&D intensity is due to a large concentration of large multinational R&D performers. The 20 largest Swedish corporations with SEK 41b account for approximately 52% of private R&D-investments localized in Sweden; in addition, 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 be interpreted with care given that many of these companies are knowledge-intensive business companies where a competitive advantage is not created through R&D but on new business models and advanced logistics.

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 on the Stockholm Stock Exchange. Subsequently, a surge in acquisitions followed in the manufacturing sector as well as for the service sector and many companies in Sweden are deeply integrated in large foreign multinationals (particularly medium sized companies) that are now driving Swedish exports. By 2003, foreign takeovers stagnated and a decrease in employment in foreign ownership can be observed since 2007. As for 2010, 13,627 enterprises with 590,304 employees (22%) were classified as having foreign ownership, an increase of 30% in five years. In general, foreign ownership is connected to larger knowledge flows and spur innovation in

technologically-advanced sectors (Aghion, et al. 2010).

TABLE 3.3. Absolute levels of R&D expenditures (BERD) Swedish enterprise sector, SEK millions in 2009 prices[14]

							Rel. change 1999
2009 prices	**1999**	**2001**	**2003**	**2005***	**2007**	**2009**	**->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 the financial sector; therefore, the sums do not match.*

3.3. Conclusion

The observations indicate that one cause of concern is on the input side of the Swedish national innovation system. The quality of public and quantity of private R&D show stagnation (although from high levels).[15] A large part of the change in private R&D is due to changed strategies in foreign-owned enterprises that suffered from the random consequences of decreased R&D available from Swedish affiliates. A survey of corporations in 2011 shows that significant further decrease in Swedish-located R&D is not a medium–term priority perspective, although that can change very quickly[16].

[14] 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 can only be interpreted as an indication of a certain dynamic.

[15] The high R&D intensity in Sweden is mainly due to the high R&D intensity in the business sector.

[16] In the summer 2012 Astra Zeneca closed down one of its oldest R&D facilities south of Stockholm. In august 2012 Sony Ericsson did the same in the south of Sweden with a planned fire of about 600 researchers and engineers.

4. ADOPTION AND DIFUSSION OF KNOWLEDGE IN THE SWEDISH ECONOMY

The Swedish innovation policy debate has centered on a number of issues related to a structure of industry that includes a strong dependence on a small number of old, large, globalized companies, whose innovative contributions to the Swedish economy have been waning over time. Furthermore, evidence shows that Sweden lags behind other countries in the absence of new high growth in innovative small and medium-sized companies. The evidence suggests that Sweden is one of the least specialized economies in the EU (Globaliseringsrådet, 2009; European Commission, 2010) and implies that the level of innovativeness (Sweden's capacity to produce new jobs) is being endangered by this unfavorable industrial structure. To what extent are the above claims valid? The next chapter describes and discusses this in some detail. We do not say that the arguments are wrong, but find evidence that provides greater insight using other type of indicators.

4.1. Specialization

The level and degree of specialization is an important driver for innovation. The most common measure is to calculate the 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[16]. Table 4.1 show the number of sectors among 68 sectors that have an RCA value higher than 1 or above for each of the selected countries in the reference group. First, Sweden 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 (pulp, paper, and wood) have RCA values above 4, which are the typical industries that characterize Swedish specialization patterns. Denmark and Finland have higher degrees of specialization with a larger share of RCA values above 2.

TABLE 4.1. Number of sectors where RCA is above 1 distributed into RCA size-groups, SITC 2 digit level, 2009

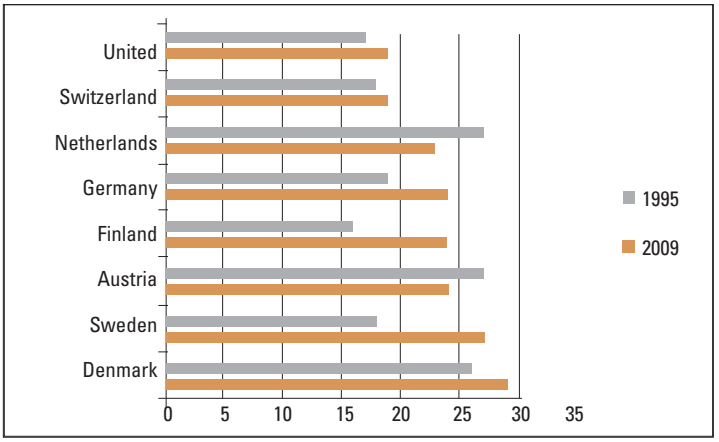
	RCA>1	1<RCA<=2	2<RCA<=3	3<RCA<=4	4<RCA
Austria	24	14	6	2	2
Denmark	29	20	6	1	8
Finland	24	13	5	0	6
Germany	24	22	2	0	0
Netherlands	23	13	5	4	1
Sweden	27	23	1	0	3
Switzerland	19	12	4	2	3
United Kingdom	19	14	3	1	1

Source: OECD stats Globalization Micro indicators on trade

[16] To characterize specialization is difficult given the quality of internationally comparable data. 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 (the 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 these types of goods.

When we look for changes over time (Diagram 4.1) Sweden is the country that 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 4.1. Number of sectors 2-digit SITC with RCA above 1, 1995 and 2009



Source: OECD stats Globalization Micro indicators on trade

This renewal has created winners and losers. Sweden has lost ground in core sectors of the Swedish economy such as telecom, motor vehicles, and the manufacture of metals; however, it has increased in various service related industries. All the same, the former sectors represent products with high value added for Sweden and the loss of specialization is in line with the projections made by Rae and Sollie (2007) with an increased competition from emerging countries.

Is 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? The use of more disaggregated Swedish data provides a more accurate picture of the degree of specialization (Table 4.2). Sweden has almost 7000 different export products, but not all of these have equal importance in terms of the export revenue generated. Instead, the limited number of products dominates Sweden's export value. Some 100 products amount to 50% of the export value, and as few as 10 different products amount to as much as 20% of the export value. These 10 products are listed in Table 4.2, which shows that Sweden has large revenues from 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 such as Astra-Zeneca (pharmaceuticals), Volvo Cars, Ericsson, Volvo Trucks and Scania Trucks (vehicles), and Stora Enso, Holmen and SCA (pulp and paper products).

In conclusion, the evidence suggested by the RCA statistics is compatible with the general productivity indicators but not with the IUS indices. The analysis from a RCA perspective show Swedish NIS as having been largely flexible and successful in a time of large global changes but also

showing some signals of losing competiveness in the core sectors of Swedish industry. In addition, Swedish specialization shows a high concentration of a limited number of mature products that might explain the sense of vulnerability often found in the Swedish policy debate[17]. This, however, lists evidence for 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; subsequently, the following two sections look into the renewal of old and new firms and the complex interdependencies that characterize innovation in the Swedish economy.

TABLE 4.2. Sweden's 10 most important "export products" 2005

Relative frequency with regard to total exports	cum rel freq	Product code in the combined nomenclature	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 (excluding 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 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), including 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 (excluding 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, (excluding 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, including 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 (excluding 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 (excluding 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 (excluding 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, including for line telephones with cordless receivers, and for videophones, n.e.s. (excluding for telephonic or telegraphic carrier-current line systems)

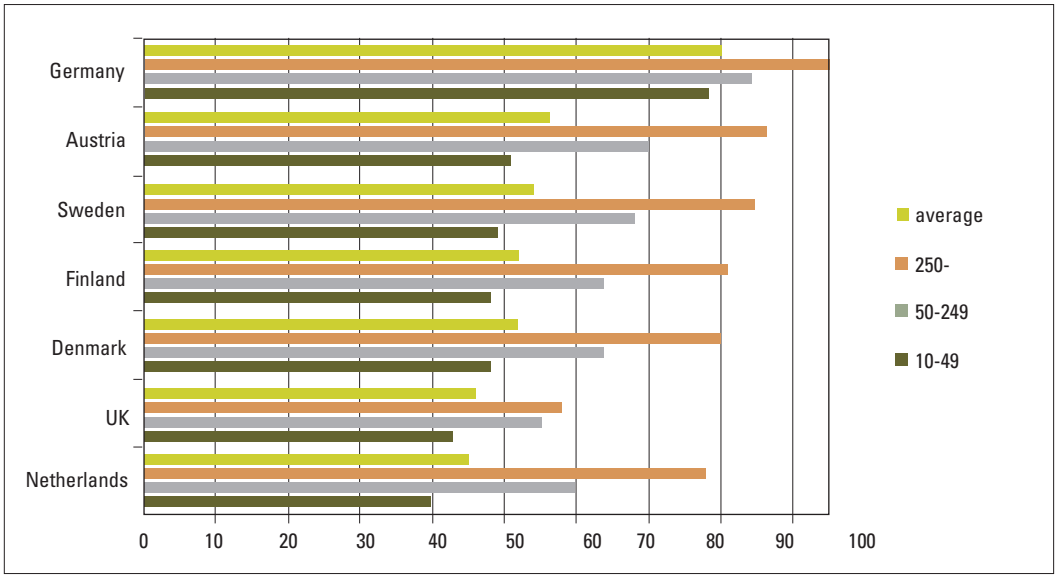
[17] Attention is needed to construct better measures indicating the specialization of countries NIS. Relying on RCA based on 68 sectors cannot be considered adequate.

4.2. Innovative Output

Two things are important when comparing countries. First, the realized productivity drives economic development in countries, not the indicators. Second, indicators of innovation have been correlated with positive productivity, but they are not the sole determinants (Hall, 2011). CIS output indicators must be interpreted with care. In the latest CIS survey, two indicators of special interest are the number of enterprises that actually perform innovation activity, and how much of the total revenue among enterprises emanates from new products or services[18].

Diagram 4.2 indicates that Sweden has similar values to other countries in the reference group. Germany stands out with a high share for all size groupings.

DIAGRAM 4.2. Share of enterprises with innovation activity 2008 average and distributed on size w r t employment (Switzerland's average is 62).

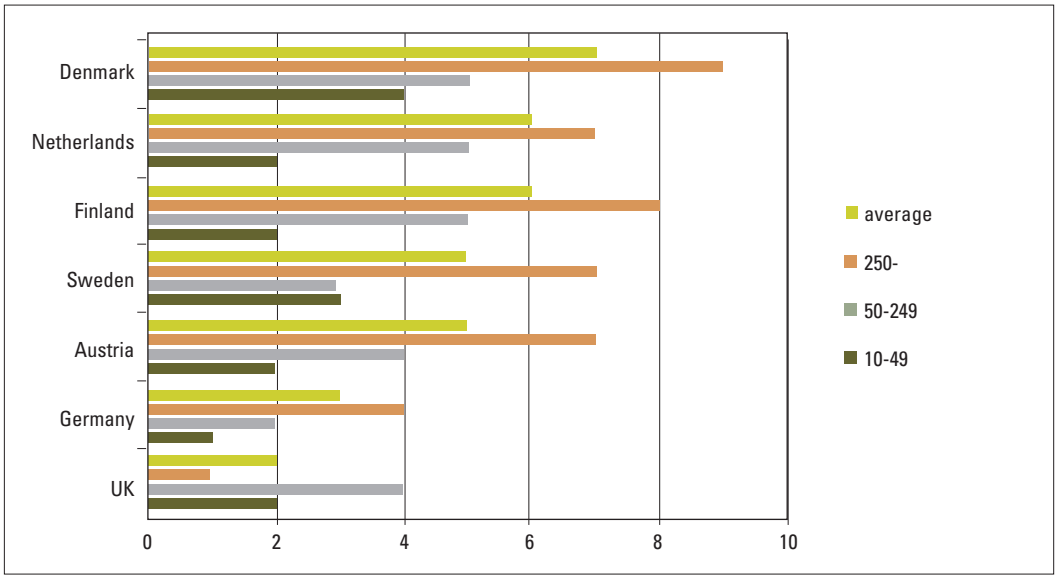


Source: Eurostat CIS 2006-2008 survey. Note: Survey data implies random errors.

As for the proportion of revenue from innovations (Diagram 4.3), the estimate for Sweden's enterprises places the share in the middle of the group for reference countries. Danish enterprises seem to have a higher revenue share from their innovations and warrants further analysis if it is a consequence of a particular Danish structure. Note that the strong estimate for innovation activity for Germany does not seem to spill over to a large share of revenue on innovation.

[18] Innovations activity is defined as the introduction of a new product/service or process or the abandonment of 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 4.3. 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

However, innovativeness can also be measured with other indicators. The structure of competitiveness has been investigated based on export statistics between 1997 and 2005 and by the means of unit cost analysis (Tillväxtanalys, 2009). 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% 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% of the OECD product prices[19].

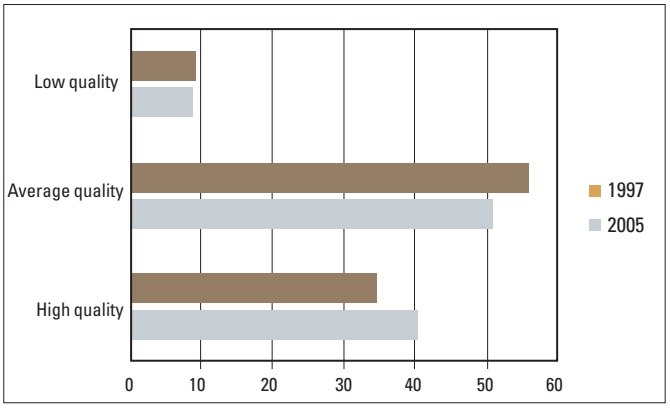
The first group (i.e., Swedish products were priced 30% higher than similar OECD products) indicates 'high quality' in the sense that despite product similarities, the Swedish enterprises were able to charge a higher price that can be interpreted as a sign of the product being of a higher quality. For example, this perception of quality difference 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.

[19] 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 that disguise the value added in a specific country.

For the second group of products (denoted here as products of 'average quality' with similar OECD prices), 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 4.4. As much as 40% 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% and suggests improved, innovative performance in Swedish industry. A decomposition of the 'high quality' proportion of 2005 shows that as much as 30% (of the 40% 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% of all products. This increased the proportion of high quality exports relative to total exports and amounted to 22% of the total number of products exported from Sweden. The export analysis is evidence (to a large extent) of Sweden's success in selling 'high quality' products between 1997 and 2005.

DIAGRAM 4.4. Distribution of Swedish export revenues with respect to "quality" categories, 1997 and 2005, percent (%)



Source Tillväxtanalys (2009)

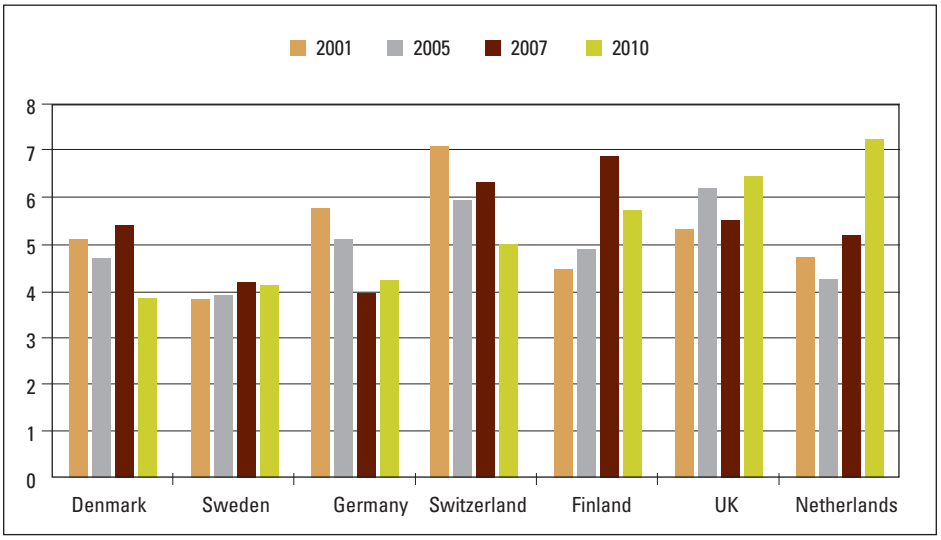
4.3. Renewal and Innovation via Entrepreneurship

Innovation is integrated in the dynamics of entrepreneurship and the Swedish policy debate has partly focused on the lack of high growth entrepreneurship in Swedish development. There remain significant problems in regards to how to measure entrepreneurship and its innovation and productivity contributions.

The TEA-indicator (Diagram 4.9) gives Denmark low values and Switzerland 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; subsequently, confidence

intervals imply that there are no significant differences between the selected countries (with the exception of the Netherlands)[20](Swedish Government, 2011a).,

DIAGRAM 4.5. GEM's TEA indicator, percent (%)

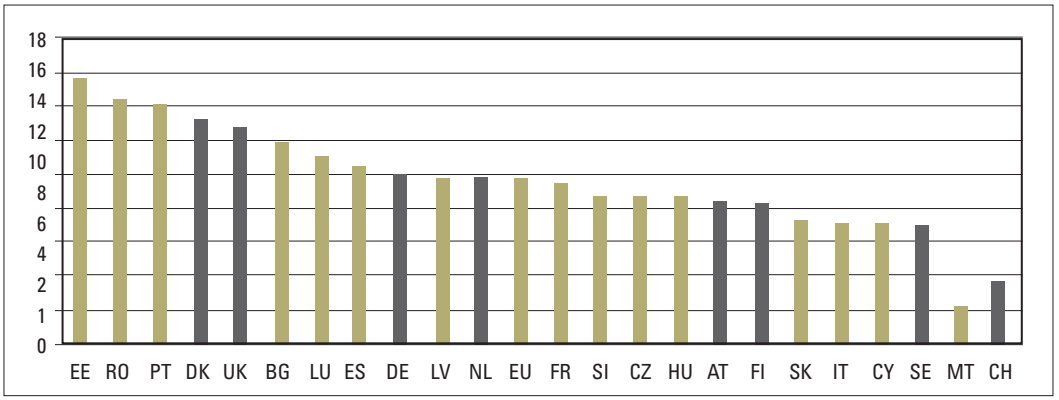


Source: Entreprenörskapsforum (2011), attachment in web-edition

Another data source on this issue is the collection of Eurostat statistics on business demography. From a policy perspective, the churn rate of the enterprise quality is an indicator of the dynamics and renewal of the economy. The churn rate is the joint effect of the following indicators: the number of start-ups (or the 'birthrate'), the survival of start-ups, and the number of enterprises exiting the population. From the Eurostat data in Diagram 4.6, we see that the birthrate differs between member-states and between the selected countries we focus on. Switzerland and Sweden are the lowest according to our group of countries with regard to enterprise birthrate.

[20] This proposition is judged from the exhibit 1.3 p 13 in Entreprenörskapsforum (2011).

DIAGRAM 4.6. Enterprise birthrate, business economy 2006 in percent (%)

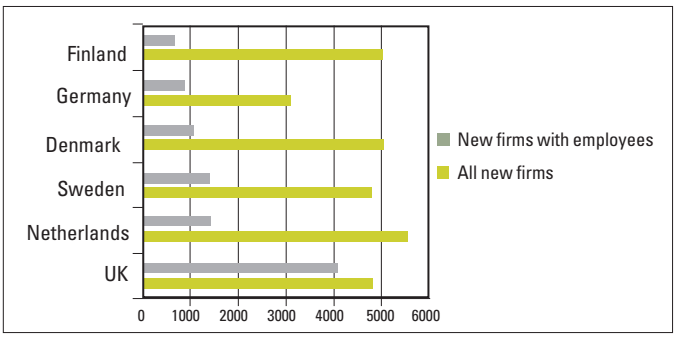


Source: Eurostat (SBS)

Unfortunately, the debate often gets stuck on this simple indicator regardless of the fact that the total renewal or 'churn' rate depends on the survival or the possibility to prosper once you have started an enterprise and the exit of non-profitable ventures. The Eurostat indicator for survival of an enterprise 2 years old puts Sweden at the top; in addition, the rate of non-profitable venture 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 would be given if the number of new firms is related to the number of inhabitants in the country. This provides an indication of the climate for 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 (Diagram 4.7). The data from Eurostat suggests 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 the Netherlands 1440. The number from the UK significantly differs and suggests that there might be differences in the administrative treatment of enterprises with no employees in the UK compared to the other countries.

DIAGRAM 4.7. Number of new enterprises per million of inhabitants, 2007



Source: Eurostat SBS database on business demography

Acs & Szerb (2010) contributed to the illustration of these dynamics. They argue that the focus on 'simple' indicators as TEA and birthrates has charged with major shortcomings that do not consider 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 (Acs & Szerb, 2010, p.6)". Thus, in order to evaluate the 'quality' of entrepreneurship, one has to put the statistics into a specific context. The Global Entrepreneurship Development Index (GEDI) elaborates the current quality of indicator information and tries to consider the 'quality' perspective. By interacting statistics on 'individual' levels with statistics on 'institutional' levels, the 14-indicator constructor is divided into three entrepreneurial dimensions of Attitude, Activity, and Aspirations (Table 4.4).

Sweden fares well in the GEDI and ranks the fourth among the 70 countries in the index. Table 4.2 shows that Denmark is number one and that the UK ranks 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; subsequently, we see that Sweden lags far behind Denmark in the Activity index.

TABLE 4.2. GEDI-index 2010 on entrepreneurship[21]

	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

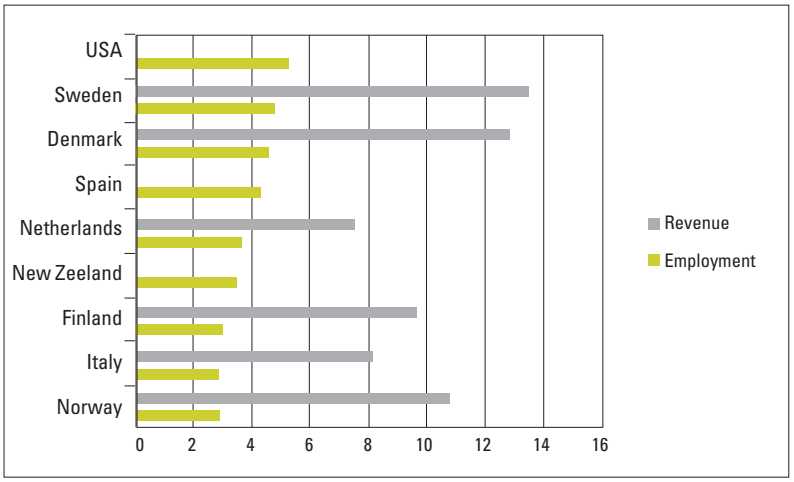
The GEDI is a new index, the validity of which needs to be discussed in more detail. The GEDI index confirms that Sweden ranks high from an entrepreneurial perspective if innovation and high growth considerations matter. However, the GEDI also suggests that areas like the quality of human resources and technology sector entrepreneurship need further attention and analysis in Sweden.

The discussion on the importance of so-called high growth enterprises has recently flourished. A venture must be on a path of high growth within a limited number of years after its startup to have an impact on general growth and structural change (i.e., creative destruction). An indicator of the number of such high-growth enterprises might be a candidate for an efficient NIS. Eurostat has compiled statistics for a small group of countries that are presented below (Diagram 4.8). Sweden

[21] Sweden the GEDI build from data of 2007; however, Sweden did not supply data to GEM for 2008 and 2009.

has a larger proportion of high growth enterprises in revenue and employment growth for 2007 when compared to Denmark, Finland, and the Netherlands (all of which are included in the Eurostat sample).

DIAGRAM 4.8. Proportion of high growth enterprises 2007 w r t growth in employment and revenue, percent (%)



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

4.4. Summary

This section analyzed the innovative performance of companies in the Swedish national innovation system. The conclusion is that Sweden has witnessed positive dynamics on the output side when viewed with indicators that measure the flow of knowledge. Thus, again it seems that some single point-indicators seen too unreliable and/or mask certain important factors behind the positive Swedish performance. The observations suggest large structural changes in the national system of innovation of a small country in the innovation frontier that are not captured by static indicators.

5. MISSING LINKAGES IN ASSESSING PERFORMANCE

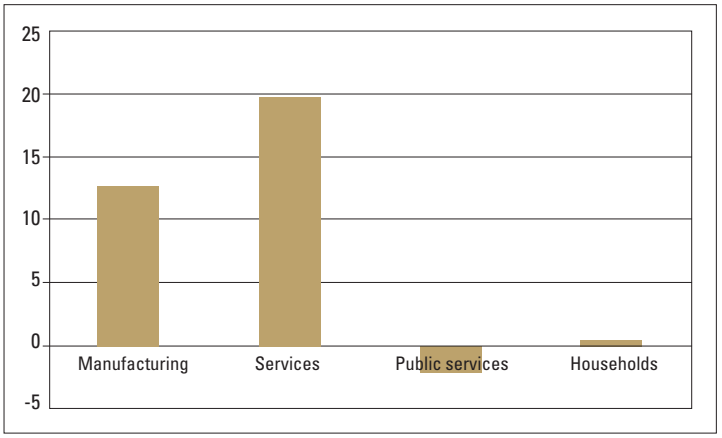
The previous evidence suggests that the assessment of Swedish performance cannot be based on explanations built on the existence of an input-output paradox that has dominated the policy debate. The analysis suggests a more complex dynamic where the understanding of the interconnection between creation and diffusion of knowledge is a more relevant starting point. We argue that the globalization of R&D and innovation challenges the way value is created in small, open economies like Sweden's, particularly since 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 and a reliance on simple one-dimensional indicators could be misleading to diagnose and frame future challenges and policy directions. We argue that

structural change in value chains and in value creation must be a part of the missing element to assess performance development and challenges for small countries in the innovation frontier.

5.1. Structural Changes

Diagram 5.1 shows the productivity contributions of various sectors in the Swedish economy where productivity growth is higher in manufacturing than in the heterogeneous service sector; however, services are becoming more important as an aggregate. In order to determine the relative contribution to aggregate productivity, a shift-share analysis shows that the private service sector contributions to labor productivity was higher than manufacturing from 1994 to 2009; however, with large variations between service sectors in terms of productivity levels and contributions. A more detailed analysis indicates that personal services have slow productivity development (lower than manufacturing); however, brokerage services have almost the same productivity development as manufacturing. Producer services showed a weak development through the 1990s with the same high manufacturing development during the last decade.

DIAGRAM 5.1. Contribution of various sectors to productivity growth in Sweden, 1994-2009, percentage (%) units



Source, Tillväxtanalys (2010b)

The increasing availability of data and attention to services has increased the understanding of service innovation and the contribution of services to productivity in the Swedish economy along with the challenges that encompass the scope of the national policy. However, these new studies imply the idea that a competitive service and industrial sector are simultaneously developing at an increasing rate in Sweden.

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 shown impressive growth in KIBS during the last decade. The contribution of KIBS to produc-

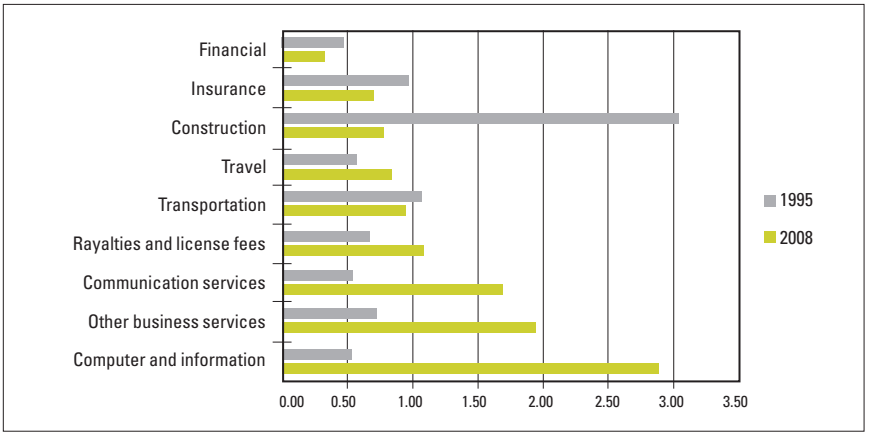
tivity development in manufacturing is high; in addition, the contribution of KIBS to development inside the sector is high and the contribution to employment growth is also the highest from 1994-2007 (Tillväxtanalys, 2010, p. 13). The amount of increase due to manufacturing outsourcing versus the increased due to demand is an unknown factor. However, when business tasks can be digitized and activities can be unbundled, it opens up possibilities to offer services to many customers in manufacturing and in services. This partly explains the rapid development in entrepreneurship presented above that includes many new KIBS.

This unbundling of services and connections to other sectors are indicated in input-output statistics as well 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 and this dependence is significant for the rapid international growth of Swedish productivity and export capacity. These interconnections (or trade-investment-service nexus) also appear in Swedish export statistics. Service exports have grown faster than manufacturing exports and represent 32% of total exports; in addition, the increased number of services may also be considered tradable (Tillväxtanalys, 2010, p. 13).

It is clear that innovation in service companies and the role of the 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 by RCA indicators) in data and communication and various producer services (Diagram 5.2).

These observations of a close connection between manufacturing and services suggest more complex innovation dynamics that the single static indicators 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 in national innovative performance.

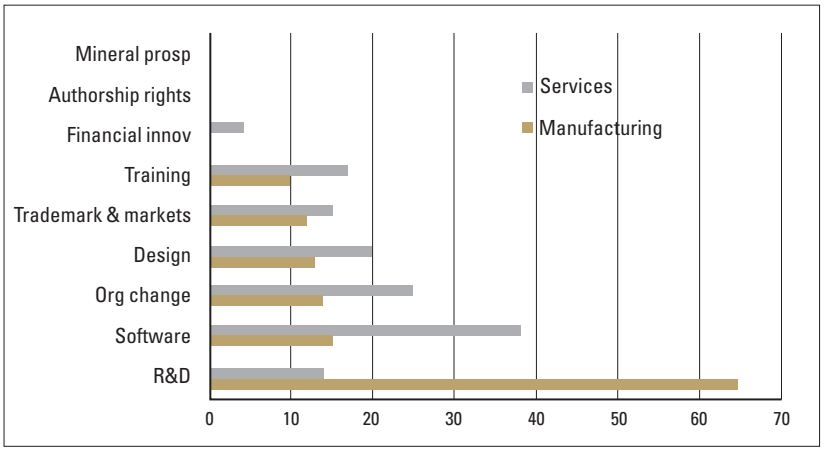
DIAGRAM 5.2. RCA indicator for different Swedish service categories 1995 and 2008



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

The structural changes and interconnectedness previously described have implications for the use of knowledge inputs and value creation in manufacturing and services. Diagram 5.3 shows that intangible investment has increased in importance. There is also long-term evidence that the manufacturing sector invests a larger share in intangible investment than in tangible (ordinary capital investments). Calculations have also shown that these intangible investments account for a significant part of total factor productivity development (Tillväxtanalys, 2010, p. 14).

DIAGRAM 5.3. Allocation of intangible investments in manufacturing and services in Sweden 2006, SEK billion



Source. Tillväxtanalys (2010)

The failure to distinguish outputs and inputs is one factor to address when assessing the performance of innovative countries in the innovation frontier. In addition, these indicators mask the large structural changes and knowledge flows that have taken place when framing the performance and challenges for small countries such as Sweden. For instance, the innovation paradox argument tends to ignore these dynamics. The unbundling of value chains may rather suggest that astrong Swedish innovation produces high economic activity, but this is not increasingly located in Sweden.

A method to capture these knowledge flows and structural changes is to analyze the existence of global value chains for a given product. The main impetus is the development of production techniques and technologies to control production and logistics by the use of digital technology and communication technology that have increased the importance of intangible capital. In addition, these discrete divisions of the value chain have transferred the concept of out-sourcing or off-shoring from one organization to another and from one region of the world to another region of the world that reinforce the need for intangible capital investment. The observations indicate that Sweden has advanced in the area of interconnectedness to develop an industrial structure that combines vertical specialization, outsourcing and off-shoring that is masked when using one dimensional and static input-output indicators. Thus, the challenges in how to measure innovative inputs and outputs are related to how productions and innovation are further integrated into networks.

6. FRAMING INNOVATION POLICY CHALLEGES IN A DISRUPTIVE WORLD

The next section shows that the interconnected features have evolved with mixed visibility in Swedish research and innovation policy.

6.1. Developments in Science and Research Policy

The political debate on the goals, level and structure of public research and innovation has been intense. The debate has emphasized several central goals such as: raising public investment in research to 1% 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[22].

The *Research and Innovation Bill* presented in 2008 can be seen as a turning point in many respects, tackling some of the 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 both the words Research and Innovation ('research' was mentioned no fewer than 453 times); however, the bill received only limited resources and attention[23].

The bill meant a significant increase (EURO 500 million from 2009-2012) in government spending on public research. The Barcelona target of 1% was achieved in 2009. Most of the funds went to universities and university colleges where new funds and 10% of the previous appropriations be distributed in a new system of quality assessments based on research citations[24]. EURO 500 million were allocated in 2009 with the goal of an annual EURO 1.8b level in 2012. Significant funding went to areas within universities, where Sweden was already considered, "world class and where society and the business sector have a major need for knowledge". These chosen areas were government decided and allocated funds by competitive bidding from the Swedish Research Council (Inno-Policy Trend Chart, 2009, p. 12).

The *Research and Innovation 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 universities with long-term 10 year funding. The initiative was labeled Innovation Offices (Innovationskontor) but did not imply the establishment of a new legal entity or organization; 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 the commercialization and diffusion of research among Swedish researchers. Similar initiatives had already been set by Vinnova but with a smaller budget compared to the new initiative in the bill[25].

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[22] 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.

[23] According to SULF (2008)

[24] Actually, the stated target was a total R&D intensity of 3 percent, where one third should be publicly-financed R&D.

The Research and Innovation Bill emphasized the transfer of knowledge from theory to application by stimulating universities to commercialize research knowledge. The bill introduced innovation as an important ingredient in science and research policy; however, it did not break with the main characteristics of Swedish policy for innovation, where university research is assumed as the major drivers and the recipients of the innovation system. Subsequently, 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.

Sweden has a long history of various collaborative policy efforts to link science with industry that can improve research, innovation and diffusion. One policy has been geared towards the improvement of research collaboration between industry and university along with another recent policy to improve the commercialization of university research through patents and university start-ups. The 'Swedish Paradox' remains the intellectual backbone of public initiatives to enhance academic entrepreneurship and commercialization; subsequently, innovation offices represent a recent policy initiative.

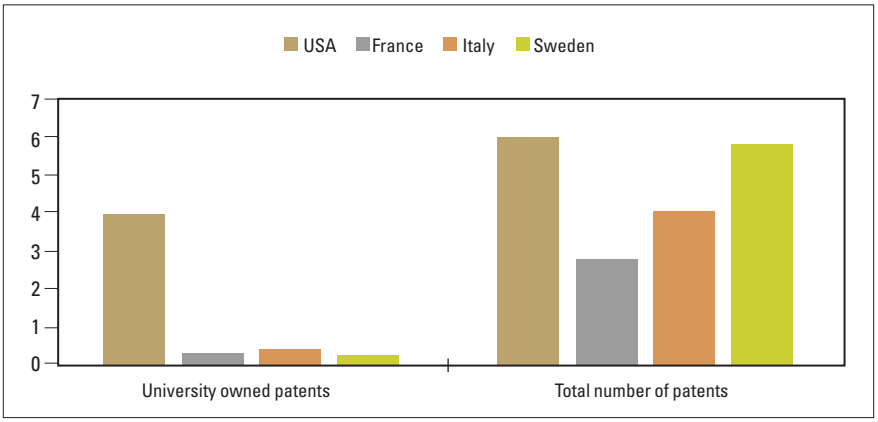
The Swedish approach to linking universities with industries has worked under the assumption that the link will not be automatic; subsequently, it is in need of various public funding mechanisms (particularly when it comes to commercialization of university research) and has the disadvantage of a top-down approach (according to the critics) (Henrekson-Rosenberg, 2001). Thus, the research question that has occupied researchers and policy makers has been how to analyze the performance of Sweden and in what ways it differs when compared to the best performers.

Recent studies indicate that Swedish universities have been better at innovation compared to what the paradox hypothesis (especially the part that looks at the 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% (and another 2% from various organizations in the public sector), which is considered high from an international perspective (Tillväxtanalys, 2011d).

Comparative data also suggest that the contributions of academic scientists to national patenting in France, Italy and Sweden are similar to that of the USA (Lissoni, Llerena, McKelvey, & Sanditov, 2008), (after correcting for the ownership of patents). In contrast to the USA (where the university owns the patent), European businesses own 60% of academic patents and with higher share in Sweden when compared to France and Italy (Diagram 6.1).

[25] "Nyckelaktörsprogrammet".

DIAGRAM 6.1. The share of university patents in US, France, Italy and Sweden, per cent (%)



Source: (Lissoni, et al. 2008)

The problem with the transfer of technology exists with universities (and single researchers); subsequently, the search for the pros and cons of existing policy and policy rhetoric requires further research attention. New international studies have indicated a more complex picture between the linkage of science and industry in Sweden and elsewhere (Hughes & Kitson, 2011). The measurement of only the number of start-ups or patents will elicit only a small part of the knowledge exchange between the sectors (Wennberg, Wiklund, & Wright, 2011).

Unfortunately, the evaluations of Swedish policy instruments to enhance collaboration are limited. Some critics point to the fallacy in the basic premise, implied by the paradox and the resulting design of Swedish policy instruments and suggest that policy design in Sweden has rested on the assumption that research and commercialization activities are substitutes rather than complements. However, a significant amount of new evidence indicates that publishing in engineering does not substitute for commercialization activities because they seem to complement each other.

Swedish public policy to enhance commercialization has focused on the creation of new start-ups from well-established researchers. This has been shown to be costly and difficult (although Sweden has produced several success stories); however, a new study shows that 528 spinoffs from Swedish universities were observed compared to 8663 corporate spinoffs from 1994 to 2001 (Wennberg et. al., 2011). The evidence shows 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; in addition, other strategies (such as the stimulating efforts directed towards students as well as the increased mobility of researchers between industry and academia) have also been less prominent in the Swedish system.

New knowledge and evidence about academic entrepreneurship and commercialization suggests a complex process and interplay of research, support structures, and individual academic engagement; however, this has not been shown in actual policy development where the R&D paradox in-

teractively dominates with technology-push programs (Reitberger & Sittenfelt, 2011).

6.2. Innovation Policy

Public efforts to stimulate the diffusion and exploitation of knowledge and technology (mainly through technology push programs) were a policy objective before the implementation of the 2008 research and innovation bill (Stevrin, 1977; Weinberger, 1997; Benner, 2009). However, the new millennium saw new methods and new policy rhetoric to describe research, innovation, and growth connections that adopt did new 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 (previously named Nutek) as well as a new emphasis on programs that stimulated innovation in SMEs, regional innovation systems, clusters and large companies (Benner, 2009; ProInno, Innovation Policy Trend Charts for Sweden 2007; 2008; 2009).

Sweden has had a consequent ambition to stimulate collaboration between research and industry through various sector specific R&D-programs (sektorforskning); however, these programs were officially abandoned in 2001. Policy ambitions to stimulate technological research and industrial development were high in the 1970s and 1980s with the creation of the Swedish National Board for Technical Development (STU) with a mission to enhance the development of new technologies and diffusion to industry. During the Social Democrat government of the 1980s and early 1990s, growth and renewal were mainly seen as conducive of favorable conditions for business that included macroeconomic stability and favorable general rules for business (Edqvist, 2007). The establishment of Vinnova in 2001 and the introduction of sector-specific research programs (branschprogram) in the late 1990s can be seen as ingredients of a more ambitious and systematic Swedish innovation policy agenda.

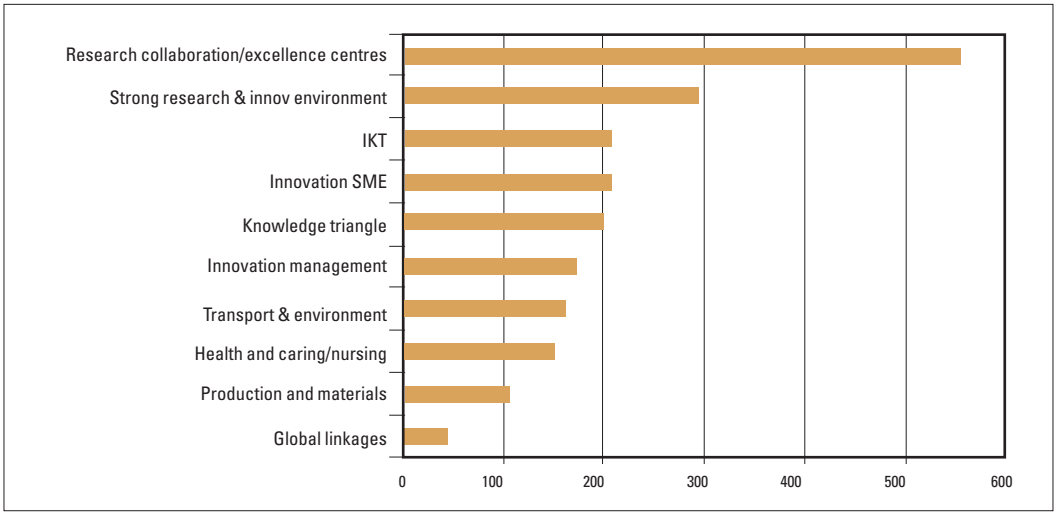
The sector-specific programs were a consequence of the ambitions of the large unions, employee federations, and some of the ministries and state research agencies with the objective of mutual cooperation and the coordination of research investments for the benefit of Swedish Industry that could also address the interests of large companies. A foundation to organize the program was laid down by a large-scale package for the troubled SAAB that was used to model new sector initiatives for automotive, forests and paper, aerospace materials, IT and Telecom, and pharmaceuticals. The program was directed towards the interests of large companies and Vinnova received an increased budget (SEK 120m) for implementing it.

The establishment of Vinnova in 2001 marked a notable change in the Swedish institutional landscape of innovation actors. It started through the diversification of its portfolio and the introduction new programs for research cooperation (VINST), a program to enhance research in SMEs (Research and Grow [in Swedish: Forska och Väx]), and an incubator program to stimulate spin-off from research (VINNKUBATOR) that was followed by an additional program with the same objective and in cooperation with Innovationsbron/Industrifonden as well as a program to enhance regional and sector innovation systems (VINNVÄXT). Program development was heavily influ-

enced by a new innovation system agenda; however, the programs were not large in the overall budget and the bulk of funding remained in various collaborative sector and technology specific R&D-programs. The assumed transformation mechanism was established with science as a source of innovation as well as an effort to increase science and industry cooperation.

Diagram 6.2 shows the current range of support measures of Vinnova and a portfolio that has more than SEK 500m to its name with a focus on collaborative programs. The collaborative programs require an active interaction between the private and public sectors. One of the largest programs in this area is the Vehicle Research Program (FFP) that was initiated by the acquisition of Volvo Cars by Ford in 1999; in addition, GM acquired the half of the ownership of the second car manufacturer , SAAB automobiles, in 2000 (Inno-Policy TrendChart Sweden, 2009, p 21).

DIAGRAM 6.2. Vinnova financed R&D 2010, SEK million, current prices (Vinnova, 2011)



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

Innovation policy has seen a broadening of initiatives through an emphasis on SMEs and regional development under the umbrella of Nutek (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 in 2001 was largely coincidental with the change in the Swedish Regional Development Policy that emphasized the stimulation of regional cohesion towards the enhancement of economic through a stimulation of innovation and entrepreneurship (prop 2001/02:4). Each region formulated regional development programs (where research, education and innovation are important) that were subsequently decided on by the government and implemented through regional partnerships between various national and regional agencies and local businesses (Tillväxtanalys, 2011, p. 1). The budget for these regional initiatives represents considerable sums of approximately SEK 10b.

These regional partnerships show various efforts of cluster building that are financed by Vinnova (part of the program for strong research and innovation environments) and Tillväxtverket (Swedish Agency for Economic and Regional Growth). Studies by the Globalization Council indicated that Sweden has introduced several cluster policies during the last 10 years (Ketels, 2009). However, the empirical analysis also showed that the number of Swedish clusters that are truly global leaders are decreasing (even when Swedish overall global markets shares were holding up quite well).

Reform ambitions throughout the last decades have also been designed to stimulate the formation of new and growing companies. A new report depicts the complex system that defines modern entrepreneurship and SME policy systems in various countries that measure the investments to enhance various forms of entrepreneurship. The previously mentioned system complexity is partially related to the many different organizations involved in delivering resources in the SME area and partly to the influence of the level of entrepreneurial activity (Tillväxtanalys, 2011). The report estimates the cost of these policies and these estimates show that a total of SEK 46.5b was invested in Swedish entrepreneurship and SME policy in 2009 (Table 5.1). The share of small business support declined from 2003-2010; however, most of the investments (with funding remaining frozen since 2003) have gone towards general SME-policy, funds to R&D, and innovation.

6.3. Limited Policy Development for a Networked Innovation System

The various initiatives and policy directions show a link between problem descriptions based on indicators and policy developments. Considerable public funds (and several new policy initiatives and experiments) have been introduced and spent to enhance the transfer of technology from academia to industry in tandem with large technology push programs designed for large companies. But what about policies for enhancing knowledge flows over technological, organizational and geographical borders and stimulating interconnectedness between horizontal sectors?

There has been a widening and deepening of innovation policies in Sweden over the last 10 years. However, several questions remain: have these changes been conducive to effective innovation policy and what measures are still missing given the structural changes described above? The strong emphasis on STI and the transfer of knowledge through universities has meant that most funding activities have had limited focus on the demand of non-R&D activities (e.g., public procurement) and the end-users of innovation as well as on the internationalization of research and innovation that are increasingly recognized in the Swedish debate. Some critics illustrate the lack of focus for demand as a significant weakness in overall policy direction and efficiency and argue that (especially for small countries) most scientific research ideas come from abroad and the competitive advantage is advanced through the integration of new ideas (from many different sources) in production processes, products, and services (Lundvall, 2008).

The integration of new ideas depends on R&D activities but also on the competence of the customers and experts and the collaborative efforts in organizational, technological, and geographical borders. To achieve these outcomes, the policy debate advocates a better balance between supply and demand in overall policy development and an emphasis on the overall innovation strategy to

enhance innovative learning to stimulate the increase of an absorptive capacity and diffusion of knowledge in the economy . This highlights the importance of a well-educated labor force as well the ability to recruit international human resources; subsequently, the analysis of these requirements indicates that Sweden may have weaknesses in both respects (OECD, 2012).

There is an increased awareness of the challenges and opportunities created by globalization that imply a need to participate in transnational networks and in EU programs (Swedish actors have improved their participation in EU programs as well as large-scale funding for various scientific fields) . The research and innovation bill of 2008 was to address the issue of internationalization; however, the importance of this issue had to acquiesce to other more important national priorities (Benner, 2009) . Recent studies show that the Swedish national innovation system has a strong international orientation (when compared to other countries); however, Sweden is more oriented towards the US and Europe than emerging markets and regions (although Sweden has a relatively favorable export balance to emerging markets compared to many other countries) Chaminade, (Zabala, Treccani, 2010).

The widening and deepening of innovation policies in Sweden shows the importance of governance issues. Innovation policy comes in two versions: broad policies that emphasize basic framework conditions versus narrow policies that emphasize specific sectors or technologies (Lundvall and Borrás, 2005). The systemic (or broad version) implies that a fundamental aspect of policy reviews and redesigns the linkage parts of the system. Swedish innovation policy has a broad and a narrow perspective with a distinctive feature of commercialization for scientific outcomes on innovation at the regional level coupled with a strong STI bias.

The combination of narrow and broad elements has initiated substantial debate over the proper design of a future innovation-enhancing policy as well as highlighting various problems and tensions in government policy. The Swedish innovation landscape consists of many stakeholders with varying degrees of coordination between ministries, funding agencies, and third-parties. The Swedish Inno-Policy TrendChart report of 2007 has additionally listed the following weaknesses in governance: a thin ministerial layer charged with policy formulation and semi-independent implementing agencies, few strong stakeholders that influence the policy debate, statistically biased propositions, ad hoc processes for the impact assessment of new regulations, and a fragmented system for policy coordination. The trend in many countries is to broaden innovation policy strategies; however, there is also some indication that this is less specified in Sweden than in Finland or Norway (Lundvall, 2008).

The expansion and experimental nature of policy action during the past decades in Sweden cannot be automatically associated with better governance or better solutions to the specific policy problems of Sweden. Table 6.1 shows an indicative assessment that applies a framework developed by Borrás et al. (2009) to specify various conditions for effective governance and various analytical criteria to assess the structure and development of innovation policy governance in Sweden. This assessment indicates that the rapid widening and deepening of Swedish policies for innovation are not always matched by effective mechanisms for innovation governance.

TABLE 6.1. 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 explicit political visions and priorities	A new 2012 strategy
Coordination at the middle level of executive departments	Vertical and horizontal coordination that 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	Embraces change and adjustment	Works well but policies are mostly supply-driven rather than demand-oriented and entrepreneurship-oriented
Clear distribution of roles for public and private actors	Extended contractual agreements into public-private partnership grey zones	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)

Swedish innovation policy has been described as: "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" (Lundvall, 2008). It is argued that policy development in Sweden has largely been shaped by available indicators and a heavy emphasis on the existence of a R&D-paradox and less on the development of more networked innovations system for Sweden to transcend corporate and national borders. Structural changes in global business will continue to shape the way the economy of small states will have to reorganize. These changes have profound impact on how Swedish innovativeness will be translated into Swedish prosperity and how innovation policy action must be designed to improve the strategic positioning.

7. CONCLUSIONS

The interest in innovation (especially in comparing the innovativeness of countries) has led to a growing number of various league-tables and indexes that provide an analysis of given various comparative indicators for the performance of Sweden benchmarked against other advanced small high-income countries. This is accomplished through a contrast of innovative performance with similar countries in Europe that critically discuss the reliability and validity of indicators widely used to shape the policy development and beliefs about policy challenges for a small country like Sweden in the innovation frontier. The Swedish policy debate has been driven by a perceived problem that Sweden has high knowledge input values but struggles to convert this into innovation (The Swedish Paradox). The analysis examines this belief and other policy assumptions from different perspectives.

The conclusion shows that available input-output indicators must be used with caution. The innovative performance of a nation is important for the evaluation of quality as well as more the ability to categorize indicators into a specific context. First, even if the supply and quality of indicators have increased for policy analysis, they still lack in precision and validity to make broad claims about the innovative performance of companies and nations. A closer look of the statistics behind various composite indexes leads to a conclusion that the variation of the selected countries (among several statistical indicators) is too great to conclude that Sweden has a systematically weaker output than other countries. It seems that composite indexes conceal this kind of uncertainty.

These indicators must be complemented and compared with other statistics in order to be legitimate. The overall indicators suggest that there is no evidence of poor Swedish performance in regards to output when Sweden is compared with seven other similar countries; in addition, the analysis points to the development of more complex innovation patterns in Sweden (and probably in other small export-oriented countries). Three overall themes have emerged that require further attention in the evaluation of the future policy analysis for the innovation frontier.

First, 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 that have an ambiguous linkage to the structure of modern business and innovation processes in small rich countries . Second, Sweden has weaknesses in the performance and organization in indicators that measures the aspects of a research system. Some issues are raised about the performance of Swedish universities to generate highly cited research and find effective national and international industry collaboration models. In addition, the analysis identified and discussed some missing conditions for the effective governance of innovation policy in Sweden. Third, the analysis suggests the development of a more complex innovation pattern in Sweden that is hidden in the structure of available and static innovation indicators. Evidence shows that the NIS of Sweden has been reorganized in complex value chains that imply 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 increased dependence between advanced manufacturing and knowledge-intensive business services. The complex and interconnected innovation systems (where R&D-intensive manufacturing and knowledge-intensive business services meet) seem to be areas where Sweden has a competitive advantage that is not fully shown by the present indicators.

These and other observations suggest that the assessment of innovative performance by small, rich, and open national innovation systems will require a careful analysis of how interdependencies have grown and what this may mean for indicator development, policy focus, design of innovation policy, and governance when knowledge increasingly flows over technological, organization, and geographical borders. The growing debate about the reliability and validity of how to measure innovative in-puts and outputs are related to a large degree on how production and innovation are integrated in networks and global value chains. The Swedish experience presented here is an example

of the need for a better understanding by rich countries on how knowledge flows shape innovation performance and how to position themselves appropriately.

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