

ERAWATCH Country Report 2009

Analysis of policy mixes to foster R&D investment
and to contribute to the ERA

Sweden

Pauline Mattsson, Marie Louise Eriksson and Tomas Åström



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investment and to contribute to the ERA

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Executive Summary

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are thus at the heart of the Lisbon Strategy. This is reflected in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This advocates increasing and improving investment in research and development (R&D), with a particular focus on the private sector. This report aims at supporting the mutual learning process and the monitoring of Member States efforts. Its main objective is to characterise and assess the evolution of the national policy mixes in the perspective of the Lisbon goals, with a particular focus on the national R&D investments targets and on the realisation and better governance of the European Research Area. The report builds on the analytical country reports 2008 and on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

Sweden is the EU country that invests most in R&D relative to its GDP. In 2007, total R&D expenditure amounted to 3.64% of GDP compared to the Member State average of 1.83%. However, in contrast to many other countries, the volume of R&D investment has decreased in recent years from a peak of 4.25% in 2001. Industry is the main R&D performer investing 2.65% of GDP in 2007. This is a decrease in comparison to earlier years (2.79% in 2006 and 2.81% in 2005). The main explanation for this is increasing globalisation, with MNC (Multinational Companies) reallocating their R&D activities to other countries than Sweden. The financial crisis will most likely result in an even further decrease of industry R&D investments (Eurostat).

The Government annually invests some €2.3b (SEK25b) (1EUR=10.81SEK) in R&D. In the research bill "A boost to research and innovation" (2008/2009:50), the government is allocating an additional €1.3b (SEK14.7b) to R&D over the period 2009-2012. This is by far the largest R&D investment ever, in terms of additional resources. Most of the government funds will go to universities and other higher education institutions.

In March 2008, the European Council made a number of recommendations for specific Member States on the basis of their 2007 Progress Reports and advice from the European Commission. No recommendations were made concerning Sweden and six other countries, but a number of "points to watch" were noted. Taking further regulatory measures to increase competition is the main point related to research and innovation. The report stated that Sweden needs to prioritise and improve management of intellectual property rights. Some measures have been taken in this regard, which will make it easier and less costly for firms to protect their inventions.

The points to watch mentioned in the National Reform Programme are very much in line with the issues raised in the research bill. There, the Government suggests that researchers at universities should be obliged to inform the university about patentable inventions he or she has made. Taken together, it is assumed that improved IPR (intellectual property rights) and a direct request to researchers and

universities to commercialise research results will lead to the establishment of new firms.

The concept of long-term funded strong research and innovation milieus with the objective of supporting innovation and economic growth is becoming increasingly popular within funding agencies. They provide a forum for collaborations between private and public sectors, universities and colleges, research institutes and other organisations that conduct both basic and applied research. The aim is to create a number of globally-recognised spearheads so that Sweden can become an attractive partner for both companies and R&D investments.

A new type of funding is introduced in the latest research bill (as a complement to direct appropriations for universities and appropriations via the research councils): strategic investments focusing on specific important areas for society and the business sector. The investments are targeting areas in which Swedish MNC are already very active and dominant players. Several of the strategic research areas are suitable for collaborative programmes.

An important feature in the research bill is its emphasis on the exploitation of knowledge production. In the bill, the Government presents an “innovation package” to increase the commercialisation of research results. Innovation offices will be set up at a number of higher education institutions. An important part of this effort is to strengthen the industrial research institutes as key actors. Therefore the Government has allocated additional resources to industrial research institutes. The intention is to improve the institutes’ role as an intermediary between academia and industry.

The threat of MNC reallocating R&D investment because of globalisation and the financial crisis are the main barriers to private R&D investments. Still Sweden’s industry is investing more than two third of the total R&D investments and Sweden will still be able to live up to the Lisbon goal. Another serious barrier to private R&D investment and the development of the NIS (National Innovation System) is the prevailing risk-averse attitudes towards entrepreneurship. There is still room for further policy initiatives focusing on the creation of new SMEs (Small and Medium Enterprises) and encouraging existing SMEs to grow and attract foreign investments. According to the most recent bill, additional funding to improve the efficiency of university holding companies will be allocated. This will mainly target the development of new firms and entrepreneurship and not increase R&D investments in already established SMEs

Globalisation does imply an increasing access to new markets but also to funding opportunities. If Sweden manages to continue providing high quality R&D it will be able to attract foreign investments and Swedish companies can expand into new markets selling products, which can then be re-invested in research.

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
The crises will most likely imply decreasing industry R&D investment	Identified strategic investments correspond to industry demand
Risk-averse attitudes towards entrepreneurship	Globalisation introduces new funding sources
Too few incentives supporting start-ups	Sweden got an international reputation of carrying out quality research
Lack of venture capital of in the earlier stages of the innovation process	Financial crisis will most likely result in even further decreased R&D investment by business sector
Low level of R&D investments in SMEs	Globalisation resulting in MNCs moving their R&D activities abroad

The ERA concept has gained increasing attention in national strategies and objectives in recent years. It is first and foremost participation in the Framework Programmes that has received stronger focus. The most recent policy bill highlighted the need to extend European collaborations, including increased cooperation between national researchers and programmes, facilitating mobility, and increasing investment in common research infrastructure. National policies addressing the need to open up national research programmes have been addressed in a number of policy documents but have not been practically implemented. Also the modernisation of research organisations has only been carried out to limited extent.

The main challenge for Sweden is to continue performing high quality research and to provide an attractive environment for foreign companies to base their R&D activities in. The ERA is aiming for an integrated research area in which other countries that have not had the national resources to invest in R&D will gain opportunities. This means that Sweden will meet increasing competition from other European countries.

	Short assessment of its importance in the ERA policy mix	Key characteristics of policies
Labour market for researchers	<ul style="list-style-type: none"> Increasing importance where EU policies have had an important role to play. 	<ul style="list-style-type: none"> Policies stimulating quality and research careers Policies facilitating mobility
Governance of research infrastructures	<ul style="list-style-type: none"> Research infrastructure plays an important role in Sweden. Sweden is a long time member of several international infrastructures and was one of the first countries drawing up a roadmap where the main focus should be to support existing ESFRI infrastructure. 	<ul style="list-style-type: none"> Research infrastructure road map in place Specific budget allocation in research bill Candidate for hosting the ESS
Autonomy of research institutions	<ul style="list-style-type: none"> Important issue among HEI (Higher Education Institutions). In the international strategy it is mentioned that increasing autonomy could facilitate and improve international collaborations 	<ul style="list-style-type: none"> Strong incentives from HEI to become increasingly autonomous. Reflected in the HEI strategies covering the period 2009-2012. Also reflected in the research policy bill.
Opening up of national research programmes	<ul style="list-style-type: none"> Few research programmes have dedicated funding for foreign based researchers. The issue was mentioned in the research policy bill but will most likely only be addressed to a limited extent. Sweden has signed the Money Follows Researcher framework and is an active participant 	<ul style="list-style-type: none"> All funding agencies and research councils have an international strategy in place for encouraging international collaborations. Majority of existing research funding programmes encourages international collaborations

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1 Introduction

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are thus at the heart of the Lisbon Strategy. This is reflected in guideline No. 7 of the Integrated Guidelines for Growth and Jobs.¹ This advocates increasing and improving investment in research and development (R&D), with a particular focus on the private sector. For the period 2008 to 2010, this focus is confirmed as main policy challenge and the need for more rapid progress towards establishing the European Research Area, including meeting the collective EU target of raising research investment to 3% of GDP, is emphasised.

A central task of ERAWATCH is the production of analytical country reports to support the mutual learning process and the monitoring of Member States' efforts in the context of the Lisbon Strategy and the ambition to develop the European Research Area (ERA). The first series of these reports was produced in 2008 and focused on characterising and assessing the performance of national research systems and related policies in a comparable manner. In order to do so, the system analysis focused on key processes relevant for system performance. Four policy-relevant domains of the research system have been distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. The analysis within each domain has been guided by a set of generic "challenges", common to all research systems, which reflect possible bottlenecks, system failures and market failures which a research system has to cope with. The analysis of the ERA dimension still remained exploratory.

The country reports 2009 build and extend on this analysis by focusing on policy mixes. Research policies can be a lever for economic growth, if they are tailored to the needs of a knowledge-based economy suited to the country and appropriately coordinated with other knowledge triangle policies. The policy focus is threefold:

- An updated analysis and assessment of recent research policies
- An analysis and assessment of the evolution of national policy mixes towards Lisbon R&D investment goals. Particular attention is paid to policies fostering private R&D and addressing its barriers.
- An analysis and assessment of the contribution of national policies to the realisation of the ERA. Beyond contributing to national policy goals, which remains an important policy context, ERA-related policies can contribute to a better European level performance by fostering, in various ways, efficient resource allocation in Europe.

¹ COM(2007) 803 final, "INTEGRATED GUIDELINES FOR GROWTH AND JOBS (2008-2010)", http://ec.europa.eu/growthandjobs/pdf/european-dimension-200712-annual-progress-report/200712-annual-report-integrated-guidelines_en.pdf

2 Characteristics of the national research system and assessment of recent policy changes

2.1 Structure of the national research system and its governance

Sweden is the EU country that invests most in R&D relative to its GDP. In 2007, the total R&D expenditure amounted to 3.64% of GDP compared to an average of 1.83% for all Member State countries. However, in contrast to many other countries, the volume of R&D investment has decreased in recent years from a peak in 2001 of 4.25%. It is first and foremost the industry that has decreased its investment in R&D, the BERD as % of GDP was in 2005 2.81% and in 2007 2.65% (Eurostat).

Main actors and institutions in research governance

Sweden has a scattered governance system and, while policy formulation is carried out largely at a ministerial level, different agencies are responsible for the design and implementation of individual policy instruments. The government ensures policy coordination at ministry level. At agency level, policy implementation is in principle dispersed and coordination is carried out informally and on an ad hoc basis. No formal and obligatory fora for coordination exist in the area of research policy and operations, and the lack of comprehensive coordination at this level is a recognised weakness (Sandstrom, SOU 2008:30).

R&D policies are mainly formulated by the [Ministry of Education and Research](#), the [Ministry of Enterprise, Energy and Communication](#) and, to a certain degree, by the [Ministry of Defence](#). Three permanent advisory bodies assist the ministries in their work. The Research Policy Council (RPC) established in 1962 and chaired by the [Ministry of Education and Research](#) has an important role in advising and assisting the ministry in preparing research policy bills every fourth year. The Innovation Policy Council (IPC) was established in 2004 and is chaired by the [Ministry of Enterprise, Energy and Communication](#). Its function is mainly to assist in communication between the ministry and its stakeholders in issues related to innovation policy. The third advisory body, the Institute for Growth Policy Studies (ITPS), reports to the Ministry of Enterprise, Energy and Communication and its main tasks are to provide analysis and policy intelligence and to evaluate governmental policies. In 2008 it was decided that ITPS, together with NUTEK (the Swedish Agency for Economic and Regional Growth) and Glesbygdsverket (the Swedish National Rural Development Agency) will be closed down and replaced by two new authorities. The reorganisation was implemented in April 2009 ([Mattsson P. and Åström T., 2009](#)).

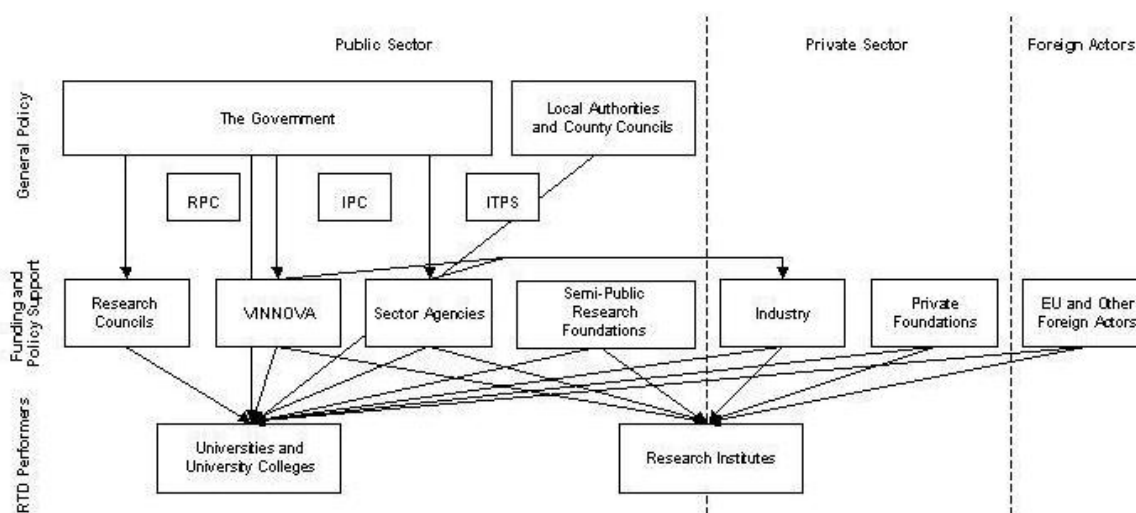
The main agency supporting R&D is the [Swedish Research Council](#) (VR), funded by the [Ministry of Education and Research](#). Its main responsibilities include funding of research across fields of natural and social sciences, medicine and education. The funding mainly takes place on an individual level, but research groups and institutions have received increasing funding in recent years. The [Swedish Council for Working Life and Social Science](#) (FAS), supported by the Ministry of Health and Social Affairs, is responsible for funding research on welfare, labour market, health and social services. The [Swedish Council for Environment, Agricultural Sciences and Spatial Planning](#) (FORMAS), supports research on ecological, conservation, natural resources-related and construction issues. The funding is provided by the Ministry of

Sustainable Development and the Ministry of Agriculture, Food and Consumer Affairs ([Mattsson P. and Åström T., 2009](#)).

In addition to these agencies there are also six major national semi-public foundations such as the [Swedish Foundation for Strategic Research](#) (SSF), which supports research in science and engineering or the [Knowledge Foundation](#) (KKS), which promotes basic research carried out at newly established universities. The other foundations include Riksbankens Jubileumsfond (RJ), an independent foundation with the goal of promoting and supporting research in the Humanities and Social Sciences; the Swedish Foundation for International Cooperation in Research and Higher Education (STINT) with the mandate to internationalize Swedish higher education and research; the Foundation for Strategic Environmental Research (MISTRA) supporting research of strategic importance for a good living environment; the Swedish Foundation for Health Care Sciences and Allergy Research (Vårdal Foundation) stimulates innovative, interdisciplinary Swedish health care science and allergy research ([Mattsson P. and Åström T., 2009](#)).

Research of an applied nature is supported by the [Swedish Governmental Agency for Innovation Systems](#) (VINNOVA). It was established in 2001 and receives its funding from the [Ministry of Enterprise, Energy and Communication](#), although it also interacts with the [Ministry of Education and Research](#) on research related issues. [Swedish Governmental Agency for Innovation Systems](#)'s area of responsibility includes funding of problem-oriented R&D and innovation-oriented activities linked to R&D. Other major R&D actors include the Swedish National Space Board, the [Swedish Energy Agency](#), and the Swedish Defence Material Administration ([Mattsson P. and Åström T., 2009](#)).

Figure 1: Overview of the governance structure of the Sweden's research system



Source: [ERAWATCH Research Inventory](#)

The institutional role of the regions in research governance

Overall, research policy is decided on the national level but in the latest government bill on regional policy, “Regional growth – for jobs and welfare” (1997/1998: 62) and “A policy for growth and vitality in the whole country” (2001/2002:4), the coordination of research and regional policy was stressed especially in relation to the development of clusters and regional innovation systems. In the government bill on

research policy “Research and renewal” (2001/2002:2), it was emphasised that those universities and university colleges that had not yet established any holding companies facilitating technology transfer should do this as part of their support to regional development. Further, the latest government bill on research policy “A boost to research and innovation” (2008/2009:50) stresses the necessity to link regional growth initiatives with national research and innovation policy. This includes improving the dialogue with regional actors and national authorities, focusing on how they can develop strategic work on research and innovation issues at the regional level.

Main research performer groups

Research in Sweden is mainly carried out by industry and the higher education sector. The business enterprise sector is the main performer with 73% of GERD in 2007 (Eurostat). The university sector is the second biggest performer, accounting for 21% of GERD. Currently, there are 61 institutions offering higher education in various forms in Sweden. Fourteen of these are state-owned universities and 22 are public or state-owned colleges for higher education. There are also a number of universities and university colleges that are self-governing and independent. They operate on the basis of an agreement with the Government and are obliged to follow the statutes, ordinances and regulations relevant to the higher education sector.

The universities have three tasks: teaching which should be connected to research, carrying out research, and cooperate with and inform society about the universities’ activities, commonly referred to as the “third task” (The Higher Education Act 1992:1434, 1 chapter, 2§). Noteworthy, the third task is very broadly interpreted in Sweden, however providing industry with mission-oriented research and carrying out technology transfer are perceived as increasingly important features of the third task. In many countries, government-run research institutes take care of this. In Sweden, research institutes only account for 3% of public R&D funding. The main role of the existing research institutes is to act as intermediaries between academia and industry by carrying out research at the level between basic research and industrial applications ([ERAWATCH Research Inventory, 2009](#)).

2.2 Summary of strengths and weaknesses of the research system

The analysis in this section is based on the ERAWATCH Analytical Country Reports 2008 which characterised and assessed the performance of the national research systems ([ERAWATCH web site](#))

The analysis of the Swedish research system’s strengths and weaknesses shows that the research carried out is of high quality, as demonstrated by a number of indicators. The main research performers are the universities, mainly carrying out basic research, and industry, carrying out applied research. Both actors are internationally recognised for performing excellent research. Sweden does already meet the Lisbon objectives with high R&D investment from both public and private sectors. Another important strength is the fact that economic specialisation and industrial needs coincide with the research focus carried out at universities. This is a result of strong public funding in fields corresponding to industry demands ([ERAWATCH Country Specialisation Report](#)).

The main weakness in the system is often said to be related to inadequate return on public investments in R&D, the so-called Swedish paradox (Ejerme & Kander, 2006). This situation can be explained by several possible factors related to the industrial structure, the entrepreneurial climate and traditions in public R&D expenditure. With an industrial structure characterised by a few MNC and many small firms, there is a risk that the institutional framework has become adapted to the dominant business model. Much of the research is conducted in the larger firms, which is partly related to limited resources among SMEs and a lack of venture capital sources resulting in limited growth opportunities. The increasing focus on co-financing in public funded research activities puts limits on which firms are able to make use of public R&D investments. Moreover, the entrepreneurial climate in Sweden is poor in comparison with many other European countries, which is reflected in its position in the lower half of the Entrepreneurship index. There are few incentives to start a firm in Sweden, which is related to the reliance of the welfare-system on the status of being an employee. Finally, there is a tradition in Swedish research policy to fund basic research. Concurrently, there is a growing expectation that research results should be economically exploited in both existing firms and new businesses. However, to exploit basic research is difficult and requires a high absorptive capacity, which mainly the larger firms have developed. In addition, studies show that academics do not start more firms than the population in general suggesting that universities have so far not been able to carry out their third task in a satisfying way (Ejerme & Kander, 2006).

The on-going globalisation process puts pressure on the NIS as MNC can decide to undertake their research activities in other parts of the world. As a result, R&D investment by the business sector has decreased in Sweden. Since it is mainly the MNCs that have invested in R&D related activities public R&D is invested in strong research areas that are identified to exhibit strong innovation capacity and dovetail with industrial specialisation.

Another weakness of the NIS is that of the governance system which is well-known for its limited horizontal coordination between ministries and little or no formal horizontal coordination between implementing authorities. The Swedish system with small ministries and relatively independent implementing authorities has resulted in scattered funding activities with many small funding programmes, and limited overlapping activities between funding bodies (Sandstrom, SOU 2008:30).

Table 1: Summary assessment of strengths and weaknesses of the national research system

Domain	Challenge	Assessment of strengths and weaknesses
Resource mobilisation	Justifying resource provision for research activities	<ul style="list-style-type: none"> • Meeting the Lisbon objectives, which gives Sweden a competitive advantage in comparison to other EU-countries
	Securing long term investment in research	<ul style="list-style-type: none"> • High R&D investment from both public and private sources.
	Dealing with barriers to private R&D investment	<ul style="list-style-type: none"> • Swedish paradox: inadequate return on public investments in R&D
	Providing qualified human resources	<ul style="list-style-type: none"> • Highly skilled R&D personnel
Knowledge demand	Identifying the drivers of knowledge demand	<ul style="list-style-type: none"> • Strong public funding specialisation in fields corresponding to industry demand • Latent R&D demand from SMEs
	Co-ordination and channelling knowledge demands	<ul style="list-style-type: none"> • Fragmented innovation system which makes demands from different actors unclear
	Monitoring of demand fulfilment	<ul style="list-style-type: none"> • Lack of systematic evaluation approach
Knowledge production	Ensuring quality and excellence of knowledge production	<ul style="list-style-type: none"> • High scientific quality according to publication and citation rate
	Ensuring exploitability of knowledge	<ul style="list-style-type: none"> • Economic strengths and industrial needs coincide with the research focus carried out at universities • Universities not able to carry out their third mission in a satisfactory way
Knowledge circulation	Facilitating circulation between university, PRO and business sectors	<ul style="list-style-type: none"> • Instruments in place targeting academic –industry collaborations
	Profiting from international knowledge	<ul style="list-style-type: none"> • Attractive research environment for international researchers e.g. tax incentives and social benefits
	Enhancing absorptive capacity of knowledge users	<ul style="list-style-type: none"> • Research intensive industry • Difficulties in commercialisation of research results

2.3 Analysis of recent policy changes since 2008

The contribution of research and research policies to the Lisbon goals (as well as to other societal objectives) goes beyond the fostering of R&D investment. It is therefore important to also analyse how other remaining shortcomings or weaknesses of the research system are addressed by the research policy mix. The focus of the section is on the analysis of main recent policy changes which may have a relevant impact on the four policy-related domains.

2.3.1 Resource mobilisation

Every electoral period, the Government presents a research bill, setting the framework for central government-funded research for the coming four years. In the latest bill “A boost to research and innovation” (2008/2009:50), the Government announced a successive increase of public funds to R&D during 2009-2012, with the aim of reaching a permanent increase of €463m (SEK5b) 2012. This implies a total increase of almost €1.3b (SEK14.7b) during the period. This budget is more than double as large as its predecessors. In 2008, public funds to R&D in the central government budget amounted to €2.4b (SEK25.6b). Following the new research bill, public funds to R&D should amount to approximately €2.8b (SEK30.6b) in 2012. The Government estimates that with the additional resources of the Research and

Innovation Policy Bill, public sector research funding will be equivalent to 1% of GDP. The increase will partly be an outcome of the abolition of the Research VAT (8%) on external funding, which corresponds to €27.7m (SEK300m) yearly.

In order to secure long term investment in research the Government is funding strong research environments, e.g. centres of excellence. There are several types of centres of excellence focusing on basic and applied research to different degrees. Centres focusing on basic research are for example, the "[Linnaeus Grant](#)" (funded by [VINNOVA](#) and [VR](#)) and the "[Berzelii Centres](#)" (funded by the [VR](#) and the [VR FORMAS](#)). Examples of centres focusing on applied research are "[VINN Excellence Centres](#)" (funded by [VINNOVA](#)) and "[Institute Excellence centres](#)" (funded by [VINNOVA](#), the [KK](#) and the [SSF](#)). A common feature of all initiatives is that funding is available for a time period of approximately 10 years.

The emphasis placed on innovation and commercialisation of research results has as its objective to mitigate the impact of the Swedish paradox (Ejermo & Kander, 2006). An important part of this effort is to strengthen the industrial research institutes as key actors. Therefore the Government has allocated additional funding of €9.2m (SEK100m) and €18.5m (SEK200m) in 2010-2012. The intention is to improve the institutes' role as an intermediary between academia and industry.

The Government has also decided to invest €11.5m (SEK125m) in 2009 to improve the quality of mathematics, natural science and engineering teaching at primary and secondary level, thus in the longer term providing a good base for students and researchers. This is a response to the decreasing number of S&T (Science and technology) graduates.

Changes in National Reform Programme regarding the role of research in the broader economic growth strategy

In 2008, the European Council made a number of recommendations for specific Member States on the basis of their 2007 Progress Reports and advice from the European Commission. No recommendations were made concerning Sweden and six other countries, but a number of "points to watch" were noted. According to the Commission and the Council's assessment, Sweden should focus on:

- taking further regulatory measures to increase competition, notably in services,
- implementation and impact evaluation of recent reforms to increase work incentives,
- tackling youth unemployment,
- raising the employment rate of immigrants,
- reintegrating people on sickness-related schemes

The aim of the Government's policy in this period is to help mitigate the economic downturn and reduce its impact on the labour market through tax relief for households and business, infrastructure and research initiatives and additional resources for the local government sector. The Government will implement reforms to improve Sweden's growth prospects by strengthening competition and improving the business and innovation climate. This will create favourable conditions under which the Swedish economy can make a rapid recovery when the global economy picks up again. The Government will therefore continue to implement structural reforms that make Sweden stronger as a nation of economic growth and strengthen welfare.

Table 2: Main policy changes in the resource mobilisation domain

Challenges	Main Policy Changes
Justifying resource provision for research activities	<ul style="list-style-type: none"> • Increased research funding in 2009-2012
Securing long term investments in research	<ul style="list-style-type: none"> • Focus on long term funding to strong research environments
Dealing with uncertain returns and other barriers	<ul style="list-style-type: none"> • Increased allocation of funding to industrial research institutes • Initiative to start up innovation offices at the universities to support commercialisation of research.
Providing qualified human resources	<ul style="list-style-type: none"> • Initiative to improve mathematics, natural science and engineering teaching at primary and secondary level

2.3.2 Knowledge demand

Every fourth year the R&D priorities for the coming years are identified and analysed in a research policy bill, prepared by the ruling government. The analyses and proposals in the research bills are based on the universities', research councils' and research foundations' research strategies, in which they present budgets, prioritised research areas, etc. The latest research bill also draws on analyses made by the so-called 'Globalisation Council' established in 2006 with the aim to promote a deeper knowledge of globalisation issues, draw up economic policy strategies, propose measures and broaden public dialogue about what needs to be done to ensure that Sweden can compete successfully in a world marked by continued rapid globalisation ([Mattsson P. and Åström T., 2009](#)).

Characteristic of the research priorities in Sweden is that they very much coincide with the business sector's demand. It is mainly the MNCs that have been in demand of R&D, rather than the SMEs, even though the picture is changing. The MNCs are mainly found in sectors such as engineering (accounting for 50% of the production), forestry, ICT, biotechnology and life sciences, environmental industries, and renewable energy. In line with this, the latest research bill "A boost to research and innovation" (2008/2009:50), introduces a new type of funding (as a complement to direct appropriations for universities and appropriations via the research councils): strategic investments focusing on strategically important areas such as medicine, technology, climate and environment, and technology, interdisciplinary science, humanities /social sciences.

Table 3: Main policy changes in the knowledge demand domain

Challenges	Main Policy Changes
Identifying the drivers of knowledge demand	<ul style="list-style-type: none"> • New type of research funding "Strategic investments" in policy fields corresponding to industry demand
Co-ordinating and channelling knowledge demands	<ul style="list-style-type: none"> • No changes.
Monitoring demand fulfilment	<ul style="list-style-type: none"> • New system for distribution of funding

2.3.3 Knowledge production

The main policy change in relation to the domain of knowledge production is the introduction of a new system for allocation of research funding outlined in the "A boost to research and innovation" (2008/2009:50). The distribution of funding between university or higher education institutions will be determined by quality - measured by two criteria – publications/references to publications and external research funds.

An important feature in the research bill is its emphasis on the exploitation of knowledge production. In the bill, the Government presents an “innovation package” of €41.6m (SEK450m) over the period 2009-2012 to increase the commercialisation of research results. Innovation offices will be set up at a number of higher education institutions. The industrial research institutes will be allocated additional funds of €64.7m (SEK700m) for the period 2009-2012. In addition, the Government proposes a change in the Higher Education Act regulating the third mission of universities and higher education institutions. Until July 2009, the universities and higher education institutions has been to enhance its involvement with surrounding communities and society. In the new Higher Education Act (applicable from 1st of July 2009), the third mission will also include that the universities and higher education institutes should “make use of” (interpreted as commercialise) research results. It is also suggested that researchers at universities and higher education institutions should be obliged to inform the universities about patentable inventions. It is unclear whether this change of law will have any profound implications on the commercialisation of research results.

In the National Reform Programme 2008, it is stated that Sweden needs to prioritise and improve management of intellectual property rights. Some measures have been taken in this regard, which will make it easier and less costly for firms to protect their inventions, e.g. in relation to patents applied for through the European Patent Office.

Table 4: Main policy changes in the knowledge production domain

Challenges	Main Policy Changes
Improving quality and excellence of knowledge production	<ul style="list-style-type: none"> • Introduction of new system for allocating research funding to universities based on quality measures
Ensuring exploitability of knowledge production	<ul style="list-style-type: none"> • Implementation of an “innovation package” to increase the commercialisation of research results • Increased funding to industrial research institutes. • A reform of the universities’ and higher education institutions’ “third mission” directly requesting them to promote commercialisation of research results • Patent reforms making it simpler and less costly for firms to protect their inventions.

2.3.4 Knowledge circulation

Knowledge circulation between academia, industry and the public sector is increasingly stressed in Swedish research and innovation policy. This is reflected in the number of programmes, launched by [VINNOVA](#), that build on the triple-helix rationale. Ongoing programmes range from sector-specific programmes, to programmes facilitating the development of regional innovation milieus. Another example is the focus on the establishment of R&D centres of excellence. These environments are often regionally based and represent a physical space for both industry and academia to interact and exchange ideas. Industry PhDs and different types of joint affiliations are another way of ensuring exploitation of knowledge generated in academia.

Another aspect of knowledge circulation is the ability to profiting from access to international knowledge. The importance of international cooperation in research is highlighted in “A boost to research and innovation” (2008/2009:50). It stresses the development of a national strategy to determine with which countries Sweden should arrive at an agreement with, see section 4.1.1. Another effort to increase openness to

international cooperation is the emphasis placed on the participation of Swedish organisations in EU Framework Programmes (FPs). Evaluations indicate that Sweden's participation has increased for every programme, e.g. in FP6 Sweden accounted for 3.6% of all participation in the programme (VINNOVA ANALYS 2008:02). [VINNOVA](#) provides special grants for project co-ordinators in order to support the development of applications for the FPs. In order to promote participation of SMEs, [VINNOVA](#) also award grants intended for preliminary studies that should eventually lead to an application. Another example of accessing international knowledge and thereby promoting knowledge circulation is the effort the Government has put into hosting the large research facility, ESS (European Spallation Source), located to Lund, see section 4.2.

Table 5: Main policy changes in the knowledge circulation domain

Challenges	Main Policy Changes
Facilitating knowledge circulation between university, PRO and business sectors	<ul style="list-style-type: none"> Continued funding of centres of excellence Many research programmes are based on the triple-helix rationale
Profiting from access to international knowledge	<ul style="list-style-type: none"> Continued support of participation in EU Framework Programmes and other international programmes Efforts to host large research infrastructure, e.g. ESS (European Spallation Source)
Absorptive capacity of knowledge users	<ul style="list-style-type: none"> No changes.

2.4 Policy opportunities and risks related to knowledge demand and knowledge production: an assessment

Following the analysis in the previous section, this section assesses whether recent policy changes respond to identified system weaknesses and taken identified strengths into account.

Increasing globalisation ensures new funding opportunities and access to a wider research base and potential collaboration partners. Increasing foreign demand for Swedish R&D services (R&D globalisation effect) and the increasing size of European Framework Programmes, Eureka etc. have made this possible. Since Swedish researchers have a good reputation for performing high-quality research, there is a readiness amongst foreign researchers to include Swedish researchers in internationally-funded research projects.

The concept of long-term funded centres of excellence with the objective of supporting innovation and economic growth is becoming increasingly popular among funding agencies. The first mid-term evaluations (Stenius and Mårtensson, 2008), have indicated high quality of knowledge production, as well as increasing collaborations and knowledge circulation between industry, academia and other stakeholders.

The main risks are related to globalisation and MNCs moving their activities abroad. Sweden has been an attractive country providing a highly skilled knowledge base for international companies carrying out R&D activities. Since the number of S&T graduates has been decreasing and other countries provide different economic benefits for companies, there is a concern that Sweden will lose out on foreign R&D investments and existing MNCs will move their activities elsewhere. Sweden is the EU country that invests most in R&D relative to its GDP. However, in contrast to

many other countries, the volume of R&D investment has decreased in recent years from a peak in 2001 of 4.25%. As mentioned above the number of graduates selecting science and engineering degrees has decreased in recent years. Since many of the MNCs are found in the high-tech sector there is a need for qualified human knowledge in these fields. If Sweden cannot provide industry with this knowledge base, there is a risk that these companies move their activities abroad. In addition, the degree of industry R&D investment as ratio of GDP has decreased which is also related to the relocation of industry to other parts of the world.

The production of entrepreneurial skills has for several years been an issue in Sweden and indicators such as the decreasing number of patents and start-ups over the last years have underscored this problem.

Table 6: Summary of main policy related opportunities and risks

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	<ul style="list-style-type: none"> • Increasing globalisation ensuring international funding opportunities • Provide an attractive knowledge base for foreign researchers to collaborate with 	<ul style="list-style-type: none"> • Increasing globalisation resulting in MNCs moving their R&D investments abroad • Declining public R&D investment • Decrease of competent research knowledge base
Knowledge demand	<ul style="list-style-type: none"> • Establishment of excellence centres will target the knowledge demand from both universities and industry 	<ul style="list-style-type: none"> • Sweden cannot live up to the international demands and increasing globalisation
Knowledge production	<ul style="list-style-type: none"> • Increasing commissioned research and teaching • Increasing collaboration with industry and international attractiveness through centres of excellence • Increasing focus on target research fields, which are in accordance with the economic specialisation 	<ul style="list-style-type: none"> • The low level of entrepreneurship at Swedish universities
Knowledge circulation	<ul style="list-style-type: none"> • The first evaluations of the centres of excellence indicate increasing collaborations between private and public sectors 	<ul style="list-style-type: none"> • Decreasing number of S&T graduates • Decreasing industry R&D investment

3 National policy mixes towards R&D investment goals

3.1 Barriers in the research system to the achievement of R&D investment objectives

Since the Swedish MNCs are dependent on skilled human resources and research, they are also interested in having a good quality public research base. In this context, the main threats to Swedish research are (“A boost to research and innovation” (2008/2009:50): inadequate quality of research, lack of long-term research funding, lack of interdisciplinary research, lack of commercialisation of research results, challenges to the independence and integrity of research, lack of ability to commit long-term and coordinated strategic investments. Several of these threats are closely related to the amount of R&D investments made in the future.

Sweden already fulfils the Lisbon goal with a R&D investment of 3.64% of GDP in 2007. Industry is the main investor with 2.65% of GDP (“A boost to research and innovation” (2008/2009:50). This means that the industry accounts for 72% of the total R&D investment with the bulk being invested in intramural research. In recent years, however, there has been a fall in industry investment. One of the reasons for this decrease in investments is that several of the big global firms have reallocated their R&D to other countries. Also the financial crisis has contributed to decreasing R&D investments. In 2005, industry invested €87m (SEK870m) in research carried out at universities in Sweden. Seventy-five percent of this amount came from firms based in Sweden. This represents about 1% of the industry’s total investment, which is rather low compared to international measures. Foreign affiliates expenditures is rather high in business R&D, accounting for 42% of the total R&D expenditures of enterprises. This is probably related to the MNCs that have ongoing activities and subsidiaries abroad. Of the hundred highest R&D investors in Europe, seven companies are Swedish owned (European Commission, 2007).

Private actors fund 15% (10% from private non-profit sector and 5% from the business enterprise sector) of the public research carried out at universities or research institutes. Just over 1% (1.3%) is of foreign origin. The Swedish government funded 5.9% of the total business R&D in 2005. This is less than the average EU27 investment of 6.9%. The government has mainly focused on funding basic research since the business sector is focusing on applied research. This might be a problem since industry investment is decreasing, resulting in applied research suffering from a lack of resources ([Mattsson P. and Åström T., 2009](#)).

There is a growing concern that the reputation of Sweden providing a good knowledge base for high-tech companies will diminish. The biggest challenge related to human resources is to replace the researchers expected to retire within the coming decade. Measures such as more secure conditions for PhD students (e.g. through salaries instead of grants) and social benefits, are being put in place to attract more postgraduates. The future provision of qualified human resources is also threatened by declining enrolment for natural science or engineering degrees in recent years.

Although Sweden has a high representation of large R&D intensive firms, the number of high-tech SMEs is low. Most investments are undertaken by MNCs and the ability to perform research among SMEs in Sweden is rather low compared to European standards. SMEs account for less than 20% of the total R&D business investments, which places Sweden in the lower half of countries in Europe. Companies with more than 250 employees are responsible for 79% of the R&D carried out in Sweden. In 2002-2004 almost half, 49%, of all enterprises were engaged in both product and process innovative activities. Across Europe, five countries perform better than Sweden, with Germany in first place having 65% of the industry involved in innovation (Eurostat). Among SME firms, 44% carry out innovative activities compared to 77% for MNCs.

One of the biggest challenges in the Swedish innovation system is to change the risk-averse attitudes towards entrepreneurship. Sweden is in the lower half of the Entrepreneurship index. A decade ago the availability of venture capital was high and it was rather easy for start-ups to receive money. Since then, investors have become more careful and do not invest in high risk projects. Despite the many policies emphasising the need to encourage start-ups, many stakeholders believe that R&D tax incentives are the only way to go in the attempt to improve the entrepreneurial culture. These types of tax deductions existed in the 1980s but have since been abolished. However, it should be mentioned that the low corporate income tax of

28% partly compensates for the lack of other tax measures and is an attempt to encourage entrepreneurship ([Mattsson P. and Åström T., 2009](#)).

Finally, it should be mentioned that the National Reform Programme, has not received that much attention in Sweden and this is due to the fact that it is very much in line with the issues addressed in the research bill.

3.2 Policy objectives addressing R&D investment and barriers

As an attempt to address decreasing R&D investment by the business sector, the Government emphasises in its latest “A boost to research and innovation” (2008/2009:50) the importance of strengthening Sweden as a successful industrial and service nation, but also as a welfare society. Research must maintain highest international quality, and research initiatives should focus on areas that are of importance for human wellbeing and industrial competitiveness. At the same time, the importance of free basic research is emphasised as it constitutes the basis for the development of applied research. To accomplish this, the Government has allocated additional resources to research for the time period of 2009-2012. With a volume of €462m (SEK5b), this bill is more than twice as large as the former bill.

In order to secure the quality of research, the funding will be distributed in accordance with a new system in which quality will determine how much each university or higher education institution will receive. Quality will be measured by means of two criteria - publications/references to publications and external research funds.

The “A boost to research and innovation” (2008/2009:50) also introduces a new type of funding: strategic investments in certain areas that have been chosen based on three criteria: research areas dealing with global problems and issues, research areas in which Sweden has shown world-class results, research areas in which Swedish firms’ pursuit of R&D and public R&D would strengthen Sweden’s industrial competitiveness. The funding is long term and focuses on a few strategic areas and as such it will contribute to making the funding system less scattered and perceived as fragmented with many small programmes targeting a wide range of areas. The introduction of these strategic investments is also important in the light of the decrease of private R&D investment as the funding is targeting research areas of direct relevance to industry.

To develop international competitive research it is important to support the development of skilled human resources at all levels in the education system. At the university level, the government has introduced a two-year post-doctoral employment scheme to make it easier for those with a doctoral degree to continue their research.

Innovation is an important theme in the “A boost to research and innovation” (2008/2009:50). This is manifested in the design of a number of new structures and instruments for the Swedish research system relating to NIS. A stronger focus on commercialisation of research results and support of technology transfer organisations are meant to address the low level of entrepreneurship in Sweden.

3.3 Characteristics of the policy mix to foster R&D investment

This section explores the characteristics and governance of the national policy and instrument mix chosen to foster public and private R&D investment. While policy goals are often stated at a general level, the policy mix is how these policy goals are

implemented in practice. The question is what tools and instruments have been set up and are in operation to achieve the policy goals?

3.3.1 Overall funding mechanisms

The government annually invests some €2.3b (SEK25b) in R&D and six semi-public research foundations contributed with another €139m (SEK1.5b). Estimates of the contributions from local authorities and county councils range up to €647m (SEK7b), but official statistics are not available. Of the Swedish government's direct R&D investment, 56% goes to curiosity-driven research and 42% to mission-oriented R&D (20% to defence-related research and 22% to non-defence-related research). The bulk of the investment in curiosity-driven research (SEK11b; €1b) is transferred directly to universities and university colleges. The remainder is funnelled through three research councils. A range of sector agencies manages the investment that is not directly defence-related ([ERAWATCH Research Inventory, 2009](#)).

The main flows of public R&D funding from the government are through: the [Ministry of Education, Research and Culture](#) aimed mainly for universities and university colleges, and to research councils; the [Ministry of Defence](#) mainly to defence agencies; and the [Ministry of Industry, Employment and Communications](#) mainly to sector agencies.

The main beneficiaries of government R&D funding are universities and university colleges, which ultimately receive over 60% of the total, as well as industry, which receives around 20%.

Funds for 'bottom-up'/free funding' projects at universities and university colleges are either directly disbursed from the government (43%), or managed by the three research councils [VR](#), [FORMAS](#) and [FAS](#). [VR](#) has the largest budget with approximately double that of [FORMAS](#) and [FAS](#) together. The majority of funding is distributed as grants. The [VINNOVA](#) is responsible for the funding of needs-driven (applied) research.

3.3.2 Policy Mix Routes

The "Policy Mix Project" identified the following six 'routes' to stimulate R&D investment:

1. promoting the establishment of new indigenous R&D performing firms;
2. stimulating greater R&D investment in R&D performing firms;
3. stimulating firms that do not perform R&D yet;
4. attracting R&D-performing firms from abroad;
5. increasing extramural R&D carried out in cooperation with the public sector or other firms;
6. increasing R&D in the public sector.

The routes cover the major ways of increasing public and private R&D expenditures in a country. Each route is associated with a different target group, though there are overlaps between routes. The routes are not mutually exclusive as, for example, competitiveness poles of cluster strategies aim to act on several routes at a time. Within one 'route', the policy portfolio varies from country to country and region to region depending to policy traditions, specific needs of the system etc.

Route 1: Promoting the establishment of new indigenous R&D performing firms

The Swedish Reform Programme for Growth and Jobs 2008 to 2010, as well as the [INNO-Policy TrendChart 2008](#), point to imbalances in the Swedish system, such as the focus on “knowledge creation” rather than “value creation”. In the new research bill “A boost to research and innovation” 2008/09:50, a number of policy changes are proposed to help redress this imbalance. Policy instruments promoting the establishment of new indigenous R&D performing firms include increased provision of venture capital, especially in the early stages of the innovation processes, the strengthening of Intellectual Property Rights (IPR) and a new initiative to establish ‘innovation offices’ at the major universities.

The main actors in the Swedish support system for innovative starts-ups and entrepreneurship are: the Innovation Bridge, [VINNOVA](#), the Industrial Fund, the University holding companies, Nutek and ALMI Business Partner ([Trendchart, 2008](#)). This is done by providing venture capital and advice, at different stages in the innovation process, and by providing incubator functions (the Innovation Bridge). Examples of programmes launched by these agencies include: “VINN Verification”, offering the possibility to conduct a more comprehensive commercial and technical verification and validation of research results with commercial potential. The programme is jointly run by [VINNOVA](#) and the Innovation Bridge. “VINN NU” is a competition also organised by [VINNOVA](#) with the aim to make it easier for new R&D based firms to prepare and clarify commercially interesting projects at an early stage so that they can apply for further funding.

The importance of IPR for economic growth is highlighted in the latest National Reform Programme from 2008. In order for a firm to be able to harness future profits from an invention, it is important that adequate protection of intellectual property is in place. Accordingly, the Government wants to make it easier and less costly for firms to register a patent. Another aspect of the IPR issue is the commercialisation of research results stemming from universities. Following today’s IPR law, the research results belong to the researcher, the so-called “university teacher’s exemption” (lärarundantaget). In “A boost to research and innovation” (2008/2009:50), the Government suggests that researchers at the university should be obliged to inform the university about patentable inventions he or she has made. Taken together, it is assumed that improved IPR laws and a direct request to researchers and universities to commercialise research results will lead to the establishment of new firms.

Improved commercialisation and knowledge transfer around universities in relation to the universities’ third task² is targeted by the bill, which encourages universities to commercialise to a greater degree the outcomes of research. This is hoped to be achieved by a change in the Higher Education Act, which more clearly lays out the responsibilities of universities to promote commercialisation of research results. Related to this is the establishment of ‘Innovation offices’ at seven universities, supporting commercialisation, patenting and licensing, etc. The Government has appropriated €6.9m (SEK75m) for these efforts. As was already proposed in the former research bill “Research for a Better Life” 2004/05:80 there is a need to develop and implement more effective holding-companies. “A boost to research and innovation” (2008/2009:50) follows the same line and allocates additional funding to

² The first and second tasks are education and research. The third task is to inform society about universities activities and research. In recent years, the third task has to increasing degree also included expectations on commercialisation and technology transfer.

improve the efficiency of university holding companies. The aim is to establish new indigenous R&D-performing firms, thus supporting route 1.

Route 2: Stimulating greater R&D investment in R&D performing firms

Against the backdrop of the financial crisis it is most likely that industry will decrease their R&D funding.

The “A boost to research and innovation” (2008/2009:50) highlights the importance of strengthening and continuing the restructuring of the industrial research sector to improve firms’ R&D investment. By allocating additional funding of some €64.8m (SEK700m) to industrial research institutes in 2009-2012 the Government is ensuring long-term funding for research institutes. The intention is to improve the institutes’ role as links between academia and industry. The institutes are particularly important for SMEs that otherwise might have difficulty accessing academic knowledge.

VINNOVA’s programme “[Research & Grow](#)”, launched in 2005, addresses Route 2 and possibly also Route 3 policy issue. This programme is targeting SMEs, and aims at funding their needs-driven R&D projects. The background is that 80% of private R&D is performed by large companies while 98% of all Swedish companies are SMEs. This calls for Route 2 policies to specifically target SMEs.

Route 3: Stimulating firms that do not perform R&D yet

In Sweden, Tillväxtverket (Swedish Agency for Economic and Regional Growth) is responsible for supporting entrepreneurship, start-ups and the development of SMEs. The agency has a wide range of measures at its disposal, which target entrepreneurship and SMEs, whereof only a few of them explicitly target firms that do not yet perform R&D. One example of this is the “Product Development in Small Companies” programme which offers direct support to business R&D through grants and loans ([Trendchart, 2008](#)). The overall budget of the programme in 2008 is €5.5m (SEK60m). Grants can be used for supporting external services, including consultancy services, development of prototypes, design etc. They require matching funding by the grant-receiving firm.

Another important actor supporting Route 3 is ALMI Företagspartner, a government-controlled organisation that aims to stimulate growth and development for SMEs and innovators by providing venture capital. ALMI’s strengths as a supportive organisation is its long-term perspective “from idea to profitable business”. The business unit ALMI Innovation, finances a number of stages in the innovation process. In 2005, 360 ideas were commercialised, and €5.8m (SEK63m) of funds were earmarked for this type of funding. €4.6m (SEK50m) of these funds were loans and €1.2m (SEK13m) was used to finance preliminary studies.³

Route 4: Attracting R&D-performing firms from abroad

The attractiveness of Sweden as a place for foreign R&D investment has mainly rested on the country’s knowledge base and its highly educated workforce. Invest in Sweden Agency (ISA) is the government agency assisting and informing foreign investors about business and investment opportunities in Sweden.

Policy instruments in place favouring Route 4 mainly focus on keeping a strong performance in terms of knowledge and innovation creation. The main policy

³ ALMI Företagspartner Getting Sweden Working
http://www.almi.se/Global/Dokument/PDF/almi_english.pdf 2009-02-25

instruments are the centre of excellence programmes and the support of strong regional innovation milieus. Since 2005, a number of centres of excellence have been implemented, e.g. the so-called “[VINN Excellence](#)” programme, “[Berzelli Centres](#)”, “[Institute Excellence Centres](#)” programme and “Industry Excellence” programme. Common for these programmes is the aim to build bridges between academia and industry by creating excellent academic research environments in which industrial companies actively participate. The “[Linnaeus Grant](#)”, jointly announced by the [VR](#) and [FORMAS](#) in 2005, is supporting strong basic-research environments at universities.

Creating strong regional innovative milieus is also a crucial strategy to attract foreign R&D-performing firms. The regionally developed policy document “Regional growth programmes”, focus on measures to stimulate innovation and entrepreneurship, based on regional conditions and needs. To some extent these programmes also include research measures. In addition, several sector agencies and semi-public research foundations implement programmes that are designed to facilitate development of clusters and centres of excellence, as well as university-based postgraduate schools in regions throughout Sweden. These programmes also include support of research activities. One example is [VINNOVA](#)’s so-called “[Vinnväxt](#)” programme launched in 2001. The aim of the programme is to support sustainable growth in regions through the development of internationally competitive research and innovation environments within specific growth areas. [VINNVÄXT](#) is a competitive programme in the sense that regions are invited to compete for financing of up to approximately €1m (SEK10m) per year for 10 years.

Route 5: Increasing extramural R&D carried out in cooperation with the public sector

The majority of Swedish policy measures are geared towards encouraging interaction (i.e. getting firms to perform some of their extramural R&D either in conjunction with universities and RIs or carried out by them). Hence, many of the research programmes launched by [VINNOVA](#) and the semi-public research foundations build on cooperation between academia, industry and public actors. These programmes operate on the matching funds principle and require industry to contribute to a project with the same amount of money that is provided by public financier. Both sector-specific and non-specific programmes exist and some of the centre of excellence also builds on this model of co-financing.

Route 6: Increasing R&D in the public sector

Route 6 is by most accounts well covered in Sweden with a public R&D intensity of 1%, but the trend in recent years is a slow decline, although the government claims that measures have already been implemented to reverse this negative trend. Thus, with an appropriation of €462m (SEK5b) covering the period 2009-2012, the latest research bill “A boost to research and innovation” (2008/2009:50) is by far the largest investment in R&D ever, in terms of additional resources. Most of the government funds will go to universities and other higher education institutions. The new feature in the research policy is the introduction of strategic investments in areas of specific importance for the development of the NIS.

The importance of education and innovation policies

In recent years, there have been concerns regarding the low number of engineers and students studying natural sciences. The Government has recently decided to

invest €11.6m (SEK125m) in 2009 to improve the quality of mathematics, natural science and engineering teaching at primary and secondary level, thus to varying degrees supporting all six routes and provide a knowledge base that is of importance for high tech companies carrying out R&D ([Mattsson P. and Åström T., 2009](#)).

Route 1 has also been given attention through the creation of enabling framework conditions that aim to improve the conditions for business development and entrepreneurship. A central part of the Government's policy to create favourable conditions for entrepreneurship is its work on regulatory simplification that aims to reduce the administrative burdens for firms by 25 % (to be reached no later than 2010). Special measures have also been taken to increase entrepreneurship among women and immigrants ([TrendChart, 2008](#)).

Assessment of the importance of policy mix routes and their balance

Table 7: Importance of routes in the national policy and recent changes

Route	Short assessment of the importance of the route in the national policy	Main policy changes since 2008
1	Starting to become prioritised with the aim to enhance the returns on public R&D investment	Improved IPR regulations A strengthening of technology transfer structure: more funding to universities' holding-companies, Innovation Bridge, Innovation offices at universities
2	Very limited explicit focus on support on firms already doing R&D. Starting to become prioritised since private R&D investment is decreasing	Increased funding to industrial research institutes
3	There are few policies explicitly targeting firms with no R&D	
4	Supported indirectly through a development of excellent research, highly skilled human labour and regional innovative milieus	Funding of centre of excellence programmes Regional development programmes
5	Majority of Swedish policy measures are geared towards encouraging interaction between academia, industry and public actors	An increasing number of research programmes and centre of excellence programmes involve interaction between academia, industry and public actors
6	Important to meet the Lisbon goal of 3%	Increased public R&D funding corresponding to 1% of GDP

3.4 Progress towards national R&D investment targets

The financial crisis will most likely result in further decreasing R&D investment from industry. It is therefore of great importance that the government compensate for these losses and allocate funding not only to universities but also to industry and stimulates inter-sector collaborations.

In the new policy bill the government allocate more additional resources into research, which is a sign of the increasing importance of research in the national agenda. Even if the importance of research has been clearly visible in earlier policy documents, the GBAORD as a percentage of the total governmental expenditure has decreased, indicating that R&D played a less important role in the last years. In 2007, GBAORD was 1.53% which is somewhat below the EU27 average of 1.55% (Eurostat).

In "A boost to research and innovation" (2008/2009:50), a new type of funding is introduced, so-called strategic investments. As mentioned above, the areas for

strategic investment have been chosen based on three criteria taking into account both research quality and relevance to society and industry. The strategic investments are targeting areas in which Swedish MNC are already active.

There is still room for further policy initiatives focusing on creating new SMEs and targeting existing SMEs. This includes both R&D programmes targeting SMEs and provision of venture capital. Entrepreneurship could be encouraged at an early stage of education in order to change the risk-averse attitudes towards entrepreneurship. One of the few positive effects of the financial crisis may be to inspire a culture of resourcefulness and openness for new ideas, which in turn might lead to the establishment of new firms.

In addition, many MNCs currently lay off people with business experience, whom could help academic researchers to commercialise their ideas. Something similar happened in the late 90s in the biotech sector, when a number of MNCs were acquired by foreign companies.

The idea of long-term funded centres of excellence with the objective to support innovation and economic growth is becoming increasingly popular among funding agencies. The first mid-term evaluations have attested to the high quality of related knowledge production and increasing collaborations and knowledge circulation between industry, academia and other stakeholders.

Table 8: Main barriers to R&D investments and respective policy opportunities and risks

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Decreasing industry R&D investment	Identified strategic investments correspond to industry demand
Risk-averse attitudes towards entrepreneurship	Globalisation introduces new funding sources
Too few incentives for starting-up a firm	Sweden got an international reputation of carrying out quality research
Lack of venture capital of in the earlier stages of the innovation process	Financial crisis will most likely result in even further decreased R&D investment by business sector
Low level of R&D investments in SMEs	Globalisation resulting in MNCs moving their R&D activities abroad

4 Contributions of national policies to the European Research Area

ERAWATCH country reports 2008 provide a succinct and concise analysis of the ERA dimension in the national R&D system of the country. This Chapter further develops these analyses and provides a more thorough discussion of the national contributions to the realisation of the European Research Area (ERA). An important background policy document for the definition of ERA policies is the Green paper on ERA⁴ which comprises six policy dimensions, the so-called six pillars of ERA. Based on the Green Paper and complementing other ongoing studies and activities, this

⁴ Commission of the European Communities: Green paper: The European Research Area: New perspectives. Brussels 4.4.2007, COM(2007) 161final (see http://ec.europa.eu/research/era/pdf/era_gp_final_en.pdf).

chapter investigates the main national policy activities contributing to the following four dimensions/pillars of ERA:

- Developing a European labour market of researchers facilitating mobility and promoting researcher careers
- Building world-class infrastructures accessible to research teams from across Europe and the world
- Modernising research organisations, in particular universities, with the aim to promote scientific excellence and effective knowledge sharing
- Opening up and co-ordination of national research programmes

In the ERA dimension, the *wider context of internationalization of R&D policies* is also an issue related to all ERA policy pillars and is normally present in the dynamics of national ERA-relevant policies in many countries.

4.1 Towards a European labour market for researchers

Access to human resources has been one of the strongest incentives for foreign companies to establish their research activities in Sweden. The share of graduates is above the EU average and the proportion of R&D personnel is high. In 2005, 24,867 people were employed as teachers and researchers at universities and university colleges and there were 9,882 PhD students. Sweden spends 6.9% of its GDP on human resources. Only Denmark is investing more.

In the 1990s a number of policy measures were put into place, such as dedicated postgraduate schools, with the objective of boosting the number of persons with postgraduate degrees. This resulted in an increase of PhDs by 70%. The major drivers were the MNCs that needed more research-educated employees. The majority of R&D personnel in the public sector work for universities, due to the limited role of research institutes. Since the unemployment rate of graduated researchers is rather low and the big companies offers secure work opportunities, often in relation to R&D activities, graduates choose to work for big companies, rather than starting their own businesses.

The financial crisis has hit the Swedish industry hard and the forecast for 2009 is gloomy. It is first and foremost the automobile industry that has been affected. As to date it is not clear what is going to happen to the mayor companies in this area: Saab, Volvo, and Scania. Other sectors have also been affected and it can be plausibly expected that companies which previously invested in research will decrease their R&D funding in the coming years. In a study carried out by Awapatent "Innovationsbarometern 2008" 12% of the polled companies stated that they will reduce their R&D investment in 2009 compared to 4% in 2008. In addition, a third more compared to last year believed that they will have less people employed in their R&D activities. At the same time, a quarter of companies (compared to 12% in the previous year) indicated that they will increase their investments, which is providing an encouraging aspect.

According to the 2007 EC report "Remuneration of Researchers in the Public and Private Sectors" Swedish researchers are located in the middle band of EU15 countries, when comparing average yearly salaries in Europe. Researchers working in the higher education sector have higher salaries than in other sectors.

The biggest challenge related to H&R policies is to secure a replacement for 45% of researchers that are expected to retire within the coming decade. Measures such as more secure income conditions for PhD students (e.g. through salaries instead of grants), as well as social benefits, are being put in place to attract more postgraduates. Perhaps the financial crisis, which may generate more limited work opportunities in the private sector, will also make it more attractive for postgraduates to pursue a career in HEI.

The number of students enrolling for natural science or engineering degrees has decreased in recent years. Closely related there is a growing concern that the reputation of Sweden providing a good knowledge base for high-tech companies will diminish. Initiatives promoting natural sciences and engineering at high schools are in place to attract more students to related university degrees.

According to the new research bill a new form of post-doc position will be introduced as a first step towards an academic career. The position covers funding for two years but can be extended up to three years in the case of parental leave, sickness or extended teaching.

4.1.1 Policies for opening up the national labour market for researchers

The Swedish universities have an international reputation for providing high quality education and in recent years the number of foreign students applying to universities has increased substantially. There are no formal admission requirements for doctoral studies with regard to Swedish language skills, since many courses are given in English. This makes it easier for foreign students to study in Sweden. In addition, both graduate and postgraduate studies are for free. The most common and secure way of funding postgraduate study is through appointment to a PhD studentship. Approximately 50% of research students have studentships. This represents the most advantageous form of funding since it also comes with social benefits and applies to both EU and non-EU researchers. Twelve percentages are funded by study grants and 17% receive some other form of funding through their institution of higher education. Sixteen percentages of the PhD students are externally funded.

Initiatives stimulating the inward mobility of foreign researchers such as tax reductions are in place. Such tax incentives include the provision that foreign experts, executives, scientists, researchers only pay tax on 75% of their income during the first three years in Sweden, a benefit that again applies to both EU and non-EU researchers.

Since 2006 EU/EEA citizens do not need any work permit to stay in Sweden. If their stay is longer than three months researchers need to register with the Swedish Migration Board. Citizens of a Nordic country (Norway, Finland, Iceland, and Denmark) do not need a residence permit. As for third country citizens a new legislation came into force on first of July 2008, which is based on the EUs Researchers Visa Directive. According to these rules no work permit is needed, if the purpose is to teach or lecture during a period of time shorter than three months. If the purpose is to be hired as a *researcher* for any period of time a work permit is required before arrival. One of the main problems has so far been that the time foreign researchers can be affiliated with universities is limited to two years. According to a new legislation on improved conditions for foreign recruitment this might be changed to four years.

The national pension system is made up of two contributions: the Income Pension which comprises 18.5% of the salary and is paid monthly by the employer into the national pensions account and the Premium Pension (2.5%) to be invested into a fund of choice.

All researchers that have a salary or a residence permit for a year or more have access to social and health insurance on the same terms as Swedish citizens. This implies that medical care is subsidised and that the individual is eligible for state-sponsored compensation in case of sickness for a prolonged period. If the stay is limited to one year but the salary is provided by a Swedish employer, individuals might still be eligible for a certificate that entitles them to medical care. If researchers are on a scholarship and not paying tax, they will not be eligible for healthcare and other benefits.

4.1.2 Policies enhancing the attractiveness of research careers in Europe and making the research community more inclusive

The Association of Swedish Higher Education (SUHF), which organises the 42 Swedish universities and university colleges, signed “The European Charter for Researchers” and “The Code of Conduct for the Recruitment of Researchers” in 2007. Most of the issues covered in these initiatives had by then already been implemented in Sweden.

Researchers’ salaries should theoretically be individually determined but are often decided centrally on faculty or research-council level. Researchers in similar positions do often have the same salaries. Most universities and university colleges are in some form of financial difficulty due to reduced funding per student, reduced base funding for R&D, and increased costs. This has resulted in universities employing researchers that are able to attract external funding.

Even though Sweden has a reputation of being a country with high standards of gender equality, there are still major inequities between men and women. Only a small percentage of high-level academic posts are occupied by women. In order to achieve more gender equality in higher education, positive discrimination can be used when recruiting staff for graduate schools and other positions. In addition, supervisors in graduate studies can be given training in gender equality and gender perspective issues.

A number of funding activities are aimed only at female researchers. The long-term objective is to increase the number of female postgraduates with the potential of becoming research leaders.

Parental leave in Sweden is probably the most generous in Europe and has served as a model for many other countries. All working parents are entitled to 16 months of paid leave per child. To encourage greater involvement by both parents a minimum of 2 months is required to be used by the parent that takes the more limited involvement in childcare, usually the father. This has resulted in more fathers staying home and employers being more tolerant towards parental leave. Still, since the women usually stay home longer and take a greater responsibility for childcare, they face professional disadvantages compared to their male counterparts. Non-permanent contracts are normally extended by up to one year in case of maternity leave or for a time commensurate to how long the parent decides to stay home. This is partly due to the fact that it is the social security system paying the parental benefit and not the employer.

4.2 Governing research infrastructures

Access to infrastructure is becoming increasingly important within many research fields and plays an important role in international collaborations. In a small country like Sweden it is a crucial task to nationally coordinate and finance the most expensive research infrastructures. This is highlighted in the research bill where an entire section is dedicated to infrastructure issues. [VR](#) is expected to spend €13.4m on research infrastructure over the period 2009-2012. In addition to this amount the government intends to contribute €13.4m in 2009, parts of which are meant to be used for the ESS, since Sweden will be the acting host.

Issues related to research infrastructure are mainly handled by the [VR's](#) Committee for Research Infrastructure that was established by the Board of [VR](#) in 2005. It formulates long-term strategies and handles resource allocation for expensive scientific equipment, large research facilities and extensive databases. The committee also represents Swedish interests in various national and international research infrastructures. Sweden is participating in several international infrastructure initiatives and has been a long time member of CERN, EFDA, ESO, IceCube, JET, EMBL, ESRF, IARC, ILL, ISIS, PRACE, GBIF, IODP/ECORD, ESS, EUI, INCF and ITER. Furthermore, a number of Nordic initiatives exist such as NORDSIM, NDGF, NORDUnet, and NOT. The overall aim of these participation efforts is to provide better conditions for Swedish researchers by ensuring access to high quality infrastructures.

The first roadmap for research infrastructure, "The Swedish Research Council's guide to Infrastructure", was published in 2006 and has since then been updated once in 2007. It was prepared by [VINNOVA](#) and the three research councils: [VR](#), [FAS](#), and [FORMAS](#). This roadmap covers all research areas and provides a basis for discussions on financing future infrastructure in Sweden as well as for participating in joint international research infrastructure. It takes a perspective of about 10-20 years. The roadmap report recommends that an investment fund should be established for large international infrastructure investment. An alternative would be to develop forms of financing that utilise investment loans from the Nordic Investment Bank or its European counterpart.

The roadmap also provides a priority list of the infrastructure elements that are of most value for the Swedish research community, industry and society as a whole. This type of list was one of the first ones of its kind in Europe. The bulk of the research infrastructure is found in natural and engineering fields with a focus on research in environment and climate areas, PRACS computing facilities, biomedicine and life sciences, but also the humanities and social sciences are of interest. The roadmap recommends that Sweden should primarily contribute to 15 out of the total 35 projects identified by the ESFRI Roadmap for Research Infrastructures. [VR](#) is participating in the planning of seven projects judged to be of particular interest. They are: ELIXIR (European Life Sciences Infrastructure for Biological Information), ESS (European Spallation Source), PRACE (Partnership for Advanced Computing in Europe), FAIR (Facility for Antiproton and Ion Research), Infrafrontier (Infrastructure for phenotyping and archiving of model mammalian genomes), LifeWatch (e-science and technology infrastructure for biodiversity data and observations), and XFEL (X-ray Free Electron Laser). Furthermore, the following projects were given a letter of support: European Biobanking and Biomolecular Resources Infrastructure (BBMRI), Council of European Social Science Data Archives (CESSDA), Common Language Resources and Technology Infrastructure (CLARIN), European Advanced Translational Research Infrastructure in Medicine (EATRIS), European

Multidisciplinary Seafloor Observatory (EMSO), European Social Survey (ESS), Integrated Carbon Observation System (ICOS), Free Electron Laser Network for Infrared to Soft X-rays (IRUVX-FEL).

Apart from European initiatives Sweden participates in a number of global infrastructures. These include, a fusion reactor (ITER), the planned millimetre telescope Square Kilometre Array (SKA), and the next generation linear collider for particle physics (ILC). Sweden also participates in the development of the neutrino telescope IceCube at the South Pole in collaboration with the United States, Germany, and Belgium.

ESS Scandinavia (ESS-S) is a consortium promoting the proposal that Sweden should offer to host ESS in Lund. In June 2009 it was decided that Sweden will host the ESS. Locating a large European research facility in Sweden will have positive effects on Swedish research and growth, and therefore financing the facility is supported by both HEI and industry equally. The construction of ESS is estimated to cost approximately €1b, and operational costs will be approximately €89m annually. The costs will be distributed among the participating countries, but Sweden is expected to cover approximately 30% of the total cost and approximately 10% of the operational cost.

The MAX IV is planned to be the next generation Swedish synchrotron radiation facility. It is a national laboratory operated jointly by [VR](#) and Lund University. In December 2008 the Swedish Government appointed Anders Flodström (University Chancellor) as a negotiator to produce a basis for a decision on the financing of the MAX IV project. A report to the [Ministry of Education and Research](#) is due in 2009.

4.3 Research organisations

The government is the major funder of research carried out at universities, mainly through block grants ([Ministry of Education and Research](#)), programs by other ministries, and competitive grants set up by the research councils and other agencies. Other important funders are private and semi-private funds, as well as the EU, businesses and local governments. There is a trend to set up collaborative centres of excellence, to which public as well as private funders have to contribute.

All in all, the universities dominate the public R&D. There are 21 PhD-granting institutions, three of which are private or semi-private, and a further 18 public institutions in the higher education sector which perform R&D. The universities were given greater autonomy in 1993 at a time when higher education and research were expanding. A commission recently suggested that they should be transformed from public agencies into a new (public) legal entity, which would grant them further autonomy.

The reform in 1993 abolished the national planning system and gave the universities the right to decide on degree programs, as well as internal management and the internal allocation of resources (within a student-based funding system for education and block grants for research). The procedures for admitting students and hiring staff are still regulated, as is the right to issue PhD's. Deregulation, greater powers for the vice chancellors, as well as external quality assurance and some privatisation elements, were introduced to increase competition and the incentives for further development of the universities. This framework has largely remained in place, although funding has been tight and efforts have been made to coordinate research through collaborative PhD-programs as well as mandatory exercises to develop

research strategies for the universities. In the mid 90's, four colleges were upgraded to university status, which gave them a larger share of R&D funding. A duty to collaborate with societal actors was written into the framework legislation. Also, the role of chairman of the board was given to an outsider, often a lay person. The most recent changes are related to the Bologna process and a new degree structure was introduced in Sweden.

There is still substantial autonomy for universities to design their research agendas. The share of block grants has decreased, which has made the universities more dependent on outside funding. A trend over the last years has been to set up collaborative centres of excellence, funded jointly by companies, funding councils, agencies and the universities. The right to hire research personnel is delegated to department chairs and often to individual project managers. The selection procedures however are regulated by law and decisions to appoint full-time staff are taken by Rectors or Deans. A great number of staff are on short-term contracts and are not covered by Sweden's strict employment regulation.

There is a long tradition of external representation in the governing boards of the universities, although such appointments have sometimes been viewed as political. The management structure of the universities has become more diversified, with either departments or faculties as organisational building blocks. The election of leaders has changed into an appointment procedure with consultations. For the position of vice chancellor an electoral college proposes a candidate to the board, which makes a recommendation to the government. Deans and department chairs are appointed by VC's after more or less informal consultations, depending on the institution. There are very few formal limitations, but still very few outsiders who have been recruited to dominant positions. A main argument for a new legal status for the universities is to allow them further room to design their organizational structures.

A public commission argued in early 2008 that universities are too dependent on external funding and suggested that one remedy would be to merge the public research councils and make sure that researchers get a more dominant role. This is part of a long debate in Sweden on the influence of external funders in relation to the academic community. An important role has been played by the semi-private funds set up in 1993, with a mission to support long-term research that is strategic for industry.

Many researchers are concerned about the increasing amount of external funding at universities will affect the autonomy to pursue their own research agendas. The decreasing amount of direct public funding to has put pressure on universities to look for other, external, sources of funding. Since the latest research bill budget more public funding to universities this might be less of a concern in the years to come.

The recent government bill introduced a model, according to which all institutions will receive base funding for research in relation to the number of students they educate. In addition, funding will be related to output (publications and citations) as well as to the amount of external funding which university manage to secure. Some restrictions will be built-in, such as calculating three-year averages and giving greater weight to social sciences and humanities. The model will be gradually introduced in 2010 as part of a general increase in funding, which is expected to make most universities net gainers under this new framework.

4.4 Opening up national research programmes

The majority of research councils and agencies have for the last couple of years worked with an international action plan which states goals and strategies related to international activities. The main goal is to make it easier for Swedish researchers to act in an international environment and for non-national researchers to work and interact with Swedish researchers. Even though international cooperation is a central part of the activities, funding is rarely available for foreign based researchers.

In the most recent research bill it is highlighted that the international dimension of research policy needs to be strengthened. As part of this the Ministry for Foreign Affairs prepared an international strategy for Swedish foreign policy "Underlag för internationell strategi i svensk forskningspolitik" (dnr U2008/2555/F). The document recommends that clear goals regarding international research collaborations should be developed at central level, as well as among universities. The long-term objective should be to allocate a specific budget earmarked for collaborations with prioritised countries. The document further discusses a number of barriers in the formulation of laws and regulations that limit international collaborations. It is not clear to what extent public research funding can be used outside the Swedish borders. On the one hand the funding is supposed to promote Swedish research, but at the same time funders are supposed to engage and develop international collaborations. According to the international strategy, international collaborations would benefit from clearer legislations that could help research funding agencies in their work towards more extensive and long term international collaborations. In the most recent research bill this issue is further elaborated. With a trend towards encouraging international collaborations, opening funding programmes to external collaborators and funding international actors may become a viable option. According to the bill such efforts will be carried out to a limited extent and the conditions on how to best implement such activities is still examined by the Government.

[VR](#) is working towards making it easier for funded researchers to transfer the grants awarded to other countries in case of relocation. [VR](#) has therefore, on the initiative of the European Heads of Research Councils (EUROHORCs), signed the Money Follows Researcher (MFR) agreement. According to this agreement, a researcher moving to a country in which there is an organisation that has also signed the MFR agreement, can take along the remaining part of a grant. Project Research Grants and Research Equipment Grants (<SEK2m) are eligible. Grants for Postdoctoral Positions cannot be transferred to another country.

Sweden has two NCP (National Contact Points) for ERA-NET: one based at [VINNOVA](#) and one at [VR](#). The latter is involved in nine ERA-NET programmes and [VINNOVA](#) is involved in 13 ERA-NET projects that fall within the block "Strengthen the Foundations for the European Research Area". [VINNOVA](#) is also involved in four ERA-NET projects that belong to Theme 2, "Technology for the Information Society". [VINNOVA](#) acts as the co-ordinator of one of these projects, eGOVERNMENT, which concerns public e-services.

4.5 National ERA-related policies - a summary

The concept of ERA is discussed in the research policy bill but does not directly address the Swedish situation. The focus is rather on Sweden's participation rate in the Framework Programmes and how further participation can be stimulated. The

NRPs have received limited attention in Sweden. This is probably related to the overlap with objectives stated by the policy bill.

The international strategy “Underlag för internationell strategi i svensk forskningspolitik” U2008/2555/F distinguishes between collaborations between Nordic, European, and other countries. The document mainly focuses on strategies targeting countries outside Europe but also highlights the importance of increasing integration with EUs FP.

There is not a great deal of mobility in Swedish higher education and the Central government has indicated that this is a problem that could undermine the standard of Swedish research. As much as 68% of students begin their postgraduate studies at the same higher education institution where they completed their undergraduate studies.

An attractive form of mobility on the other hand is studying abroad. Swedish institutions of higher education have many contacts with similar institutions in other countries. Both students and teachers/researchers take part in exchange programmes or apply to foreign institutions of higher education on their own initiative. Over the last few years, approximately 900 Swedish PhD students have gone abroad to study, and about the same number of foreign PhD students have come to Sweden. Most of these students can be found in technology related fields, and the exchanges most often take place with EU countries and the USA. These initiatives are not a direct result of national policies but rather through bilateral agreements between universities and European efforts to encourage mobility such as the Marie Curie grants and the Erasmus programme. The fact that Sweden is a small country with a limited national research arena is a contributing factor to the high outward mobility.

National policies have rather focused on inward mobility e.g. tax incentives and legislations making it easier to employ foreign researchers. The latter is mainly a result of joint European efforts and is based on EUs Researchers Visa Directive. Also the favourable social system and English being the language that predominates in theses and courses makes Sweden an attractive country to carry out research in. The number of foreign PhD students is gradually increasing and 20% of all PhD students were born outside Sweden, also the number of foreign nationals among postgraduate students is growing, about 20% of active postgraduate students were born abroad, the majority of them earn their degree in the natural or technological sciences, or in medicine.

The importance of international research infrastructure is addressed by a number of national policy documents. In the research policy bill an entire section is dedicated to infrastructure issues. A specific committee, the Swedish Research Council's Committee for Research Infrastructure, only dealing with infrastructure issues has been set up by the Swedish Research Council. In 2006 a roadmap providing a priority list of the 35 projects identified by the ESFRI Roadmap for Research Infrastructures was published. Sweden is also an active member in participating in the planning of a number of European infrastructures and will host the European Spallation Source (ESS) in Lund.

The importance of ERA-related policies in the modernisation of research organisations has not been as visible as in opening of national labour markets of researchers and the construction of research infrastructures. It is first and foremost the Bologna Process, which aims to increase cooperation and mobility in higher education and research in Europe, which has led to fundamental changes in the system of higher education in Sweden. On July 1st, 2007 a new organisation was

introduced for programmes and qualifications. (Government Bill Ny värld - ny högskola (New world - new higher education)).

The importance of opening up of national research programmes has been addressed in a number of policy documents but has not been practically implemented. Even though international cooperation is a central part of the activities, funding is rarely available for foreign based researchers. In an international strategy for Swedish foreign policy “Underlag för internationell strategi i svensk forskningspolitik” (dnr U2008/2555/F) clearer legislation is identified as a mean to help research funding agencies in their work towards more extensive and long term international collaborations. In the most recent research bill efforts opening up funding programmes to external collaborators and funding international actors will be carried out to a limited extent and the conditions on how to best implement such activities is still examined by the Government.

Table 9: Importance of the ERA pillars in the ERA policy mix and key characteristics

	Short assessment of its importance in the ERA policy mix	Key characteristics of policies
Labour market for researchers	<ul style="list-style-type: none"> Increasing importance where EU policies have had an important role to play. 	<ul style="list-style-type: none"> Policies stimulating quality and research careers Policies facilitating mobility
Governance of research infrastructures	<ul style="list-style-type: none"> Research infrastructure plays an important role in Sweden. Sweden is a long time member of several international infrastructures and was one of the first countries drawing up a roadmap where the main focus should be to support existing ESFRI infrastructure. 	<ul style="list-style-type: none"> Research infrastructure road map in place Specific budget allocation in research bill Candidate for hosting the ESS
Autonomy of research institutions	<ul style="list-style-type: none"> Important issue among HEI. In the international strategy it is mentioned that increasing autonomy could facilitate and improve international collaborations 	<ul style="list-style-type: none"> Strong incentives from HEI to become increasingly autonomous. Reflected in the HEI strategies covering the period 2009-2012. Also reflected in the research policy bill.
Opening up of national research programmes	<ul style="list-style-type: none"> Few research programmes have dedicated funding for foreign based researchers. The issue was mentioned in the research policy bill but will most likely only be addressed to a limited extent. Sweden has signed the Money Follows Researcher framework and is an active participant 	<ul style="list-style-type: none"> All funding agencies and research councils have an international strategy in place for encouraging international collaborations. Majority of existing research funding programmes encourages international collaborations

5 Conclusions and open questions

5.1 Policy mix towards national R&D investment goals

The threat of MNC reallocating R&D investment because of globalisation and the present financial crisis must be seen as the main barriers to private R&D investments. Still Sweden's industry is investing more than two third of the total R&D investments and Sweden will still be able to live up to the Lisbon goal. Given the tradition in Sweden to invest most public R&D funding in basic research at universities, it is important that the government also allocates money to inter-sector

collaborations between academia and industry. The introduction of 'strategic investments' is partly in line with this as it focuses on research areas corresponding to industry's needs.

Since the majority of research is carried out by MNC and the number of medium sized companies is low there are no obvious replacers that can attract foreign investment if MNCs reallocate their R&D spending to other countries. The number of start-up companies is rather high in Sweden but there has been a problem for these companies to grow. Medium sized companies are more likely to contribute to economic growth and penetrate an international market.

Fragmentation and lack of coordination between research funding bodies are two crucial threats to the development of the Swedish R&D system. Here, concepts of long-term funded centres of excellence based on co-funding from several funding agencies might contribute to reduce some of these negative features of the system. In addition, the first mid-term evaluations of the centres have indicated a high quality of the knowledge production and increased collaborations and knowledge circulation between industry, academia and other stakeholders.

5.2 ERA-related policies

ERA has had a rather limited role in Swedish research policy but in recent years it has gained increasing attention in national strategies and objectives. It is first and foremost participation in the Framework Programmes that has evolved into a stronger focus. In 2007, the Government implemented a number of measures with the objective to stimulate Swedish participation. These include continuing efforts to exert influence on the Commission during the implementation of the programmes and to support Swedish FP applications, as well as commenting on the Green paper and on the future of ERA. Sweden has in general a positive attitude towards the Green paper and the future of ERA. The most recent policy bill highlighted the need to extend European collaborations, including increased cooperation between national researchers and programmes, facilitating mobility, and increasing investment in common research infrastructure. National policies addressing the need to open up of national research programmes have been addressed in a number of policy documents but have not been practically implemented. Also the modernisation of research organisations has been carried out to limited extent. It is first and foremost the Bologna Process that has led to fundamental changes in the system of higher education in Sweden.

The main challenge for Sweden is to continuing performing high quality research and to provide an attractive environment for foreign companies to carry out R&D activities. The ERA is aiming for an integrated research area in which other countries that have not had the national resources to invest in R&D will gain opportunities. This means that Sweden will meet increasing competition from other European countries.

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List of Abbreviations

FP	European Framework Programme for Research and Technology Development
HEI	Higher education institutions
HES	Higher education sector
MNC	Multinational Companies
NIS	National Innovation System
NRP	National Reform Programme
PRO	Public Research Organisations
R&D	Research and development
SF	Structural Funds
SMEs	Small Medium Enterprises
S&T	Science and technology

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Abstract

The main objective of the ERAWATCH Policy Mix Country reports 2009 is to characterise and assess in a structured manner the evolution of the national policy mixes in the perspective of the Lisbon goals, with a particular focus on the national R&D investments targets and on the realisation and better governance of the European Research Area. The reports were produced for all EU Member State and six Associated States to support the mutual learning process and the monitoring of Member and Associated States' efforts by DG-RTD in the context of the Lisbon Strategy and the European Research Area. The country reports 2009 build and extend on the analysis provided by analytical country reports 2008 and on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

This report encompasses an analysis of the research system and policies in Sweden.

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