Policy Mix Peer Reviews

Country Report: Sweden

Second Cycle of the Open Method of Coordination
for the Implementation of the 3% Action Plan

Report prepared for the CREST Policy Mix Working Group
by Ken Guy, Wise Guys Ltd., in conjunction with IPTS

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R&D and Innovation Policies in Sweden

Report of the Policy Mix Review Team

Introduction

As part of the policy mix peer review process instigated by CREST during the second cycle of the Open Method of Coordination, a review team comprised of representatives of EU Member States, the European Commission and an independent consultant visited Sweden on June 8-10 2005.[1] During this period, Ann-Katrin Berglund and Susanne Moberg, the Swedish representatives on the Policy Mix Expert Group, arranged interviews with a variety of stakeholders in the Swedish R&D and innovation policy system.[2]

This report is based on material collected during the review visit and on material contained within a draft background document prepared by IPTS.[3] It represents the collective view of the review team but does not represent the official view of any of their host organisations. It was discussed with Swedish policymakers during the course of a feedback mission in early September and constituted an input into the Policy Mix Peer Review Meeting that took place on September 16 2005 in Brussels. After suitable amendment, the main elements of the report were then incorporated into a synthesis report to CREST on the peer review of R&D and innovation policy mixes in three countries: two EU Member States (Spain and Sweden) and one Applicant Country (Romania).

The remainder of the report is structured in three sections. The first provides a thumbnail sketch of the Swedish R&D and innovation system and its associated policy mix. In the second section, some of the most important impressions gained by the review team are recounted, together with suggestions for future policy that might be considered appropriate in a Swedish setting. In the final section, those lessons of more generic applicability in other settings are picked out and emphasised.

The Swedish R&D and Innovation System and Policy Mix

Sweden has a strong, stable economy with relatively high GDP per capita, a well-educated population and a stable social and political framework. Trade in global markets and high exports have been a feature for many decades. It also has an extremely strong and well-developed innovation system, as evidenced by most indicators. As a percentage of the active population, the share of science and engineering graduates is above the EU average and the proportion of R&D personnel is considerably higher. In the public sector, most of these are located within universities, since there is only a very rudimentary Research Institute (RI) sector, with universities tasked to educate, conduct research and interact with industry (the 'third task'). Funding for research within universities is higher than in most EU or OECD countries and comprises direct state allocations (42% in 2003), state funds for which universities compete (15% from Research Councils and 20% from other sources), and the remaining 23% from other

[1] Full details of the review team are presented in Appendix 1
[2] Full details of the interview schedule are presented in Appendix 2
[3] IPTS, Policy Mix Peer Review: Sweden, June 2005 – see Appendix 3

non-governmental sources (industry, non-profit organisations and sources abroad)[4]. Despite the 'third way' remit of universities, however, research revenue from private sector companies only amounts to 6% of the total[5]. In output terms, the Swedish science base is also prolific, with scientific publications per million of the population double the corresponding figure for Europe as a whole.

The strength of the public sector science base is complemented by an extremely strong, R&D intensive private sector. Forty out of the top 500 high R&D spenders in the EU have headquarters based in Sweden, with large R&D performing subsidiaries of other MNCs also located there too. Leading sectors include ICT (Ericsson), engineering and machinery (Volvo, Scania, Atlas Copco, ABB) and pharmaceuticals (AstraZeneca). Employment in medium-high and high-tech manufacturing is around the EU average and employment in high-tech services considerably greater than average. R&D personnel figures are substantial and the high R&D intensity in the public sector is surpassed in the private sector, making the ratio of overall R&D expenditure to GDP one of the highest in the world. On the output side, patent applications rose steeply over the 1990s and, in terms of overall innovation performance, as measured by the European Innovation Scoreboard, Sweden is also a world leader, with sales of 'new to market' products and 'new to the firm but not to the market' products as a percentage of turnover at and above the EU average respectively. The absorptive capacity of the economy for innovative goods and services is also considerable. Progress towards a knowledge-based society, for example, is highly advanced in Sweden, with Internet access and use double the EU average.

Public policies undoubtedly underpinned Swedish success in terms of establishing a successful educational infrastructure and public sector science base. They also helped shape the development of the industrial sector over time. Public procurement policies in the defence sector played their part, as did similar policies in the telecommunications arena, where the interaction between the state telecommunications agency and Ericsson (especially between their respective R&D arms) helped pave the way for Ericsson's current success on the world stage. The dynamism of the private sector, however, also contributed greatly to the successful functioning of the overall innovation system, and for many years policymakers were primarily preoccupied with 'fine-tuning' the system and incremental improvement rather than with efforts to initiate radical change or stimulate step-change performance improvements.

In recent years, however, there has been a growing policy debate about the continued health of the innovation system. One element of concern was a manifestation of the so-called European paradox – or the Swedish paradox in this context. Although innovation performance was high, it was not commensurate with the very high levels of R&D intensity in Sweden. Similarly, although GDP was relatively high, growth rates were sluggish and overall levels again not commensurate with the input side of the equation. Unemployment levels were a problem too and the debate focused on the suggestion that the innovation system as a whole was not as efficient as it could be in 'translating' R&D into economic performance.

Another concern that exercised policymakers was related to globalisation. Many Swedish-owned companies had become subsidiaries of MNCs with headquarters based in other parts of the world, while others had large proportions of their shares held by foreign stakeholders. There was also a shift in terms of the R&D performed by these companies, with the loss of some capacity to facilities in other countries (especially in pharmaceuticals), down-scaling by others (ICT), and more overt foreign control over

[4] All figures provided by the Swedish Ministry of Education, Research and Culture.
[5] Swedish Universities and University Colleges, Short version of annual report 2004, p21

research agendas. The fear, therefore, was that Sweden might lose footloose R&D capacity and fail to capture other foreign direct investment.

The associated waves of liberalisation and deregulation of markets that accompany globalisation also created other tensions within the innovation system. While undoubtedly a factor in the overall Swedish success story in recent years, these waves also led to the erosion of highly successful public-private partnerships and procurement relationships between state and private sector institutions, especially in the telecommunications and defence sectors.

All these concerns and debates, coupled with a desire to meet new societal goals related to sustainability, the environment, ageing populations and the creation of an advanced knowledge-based society, led to a re-examination of the policies in place to maintain and improve the health of the innovation system. Adopting an explicit national innovation systems approach, a White Paper in June 2004 set out a framework for the revision of public policy in this sphere (see Exhibit 1). The policy mix it advocated called for actions in four broad areas:

- Knowledge Base for Innovation.
- Innovative Trade and Industry.
- Innovative Public Investment.
- Innovative People.

Responding to many of the concerns being voiced in contemporary debates, the comprehensive range of instruments and measures discussed in the paper included policy packages aimed at:

- Strengthening the education and research base in order to maintain the required throughput of qualified personnel and continue to act as a magnet for the co-location of high-R&D intensive industry, thus helping to retain existing footloose R&D capacity and attracting further foreign direct investment via the creation of 'attractive knowledge environments'.
- Improving the linkages in the system – particularly between the science base and industry and within the context of regional innovation clusters – in an attempt to improve the overall efficiency of the system.
- Revitalising public procurement as a driver of innovation and a link between R&D, innovation and the market.

The review also recognised and attempted to deal with a critical perceived weakness in the overall innovation system, namely its limited capacity for 'renewal' via the creation and subsequent growth of high-tech SMEs. Although Sweden has many large R&D intensive firms, it has a relatively small high-tech SME sector and a weak entrepreneurial culture, with individuals accustomed to seeking employment in the public sector or large company environments rather than embarking on the high risk road of starting and growing their own companies. The White Paper thus suggested the need for a number of instruments aimed at stimulating entrepreneurship and supporting the formation and growth of new commercial initiatives. One possibility being considered is the co-funding of R&D activities via a Small Business Innovation Research (SBIR) initiative, to be operated by Vinnova, the state agency with responsibility for innovation systems. This is a fairly radical suggestion in a Swedish context given that – unlike in many other countries – there is no overt tradition of direct (as opposed to indirect) financial support to firms for R&D on an industry-wide basis,[6] though there is a strong tradition of funding

[6] State support for collaborative R&D projects, for example, generally goes to universities, research institutes and other organisations rather than to firms, which are expected to pay their own way.

Exhibit 1 The Framework for Swedish R&D and Innovation Policy, 2004

Knowledge Base for Innovation			Innovative Trade and Industry		Innovative Public Investment			Innovative People	
Ensure that Swedish education and research are of world class	**Concentrate efforts in Swedish profile areas**	**Utilise the opportunities of globalisation**	**Strengthen existing small and medium sized enterprises' innovative capacity**	**Increase commercialisation of research results and ideas**	**Use the public sector as a motor for sustainable growth**	**Promote renewal and efficiency in the public sector**	**Develop infrastructure that promotes renewal and sustainable growth**	**Stimulate entrepreneurship and enterprise**	**Allow people's competencies to be utilised**
Promote mathematical knowledge and interest in scientific and technical education	Prioritise strategic areas in research and industry	Promote good language skills	Strengthen strategic co-operation between business networks and universities, higher education institutions and research institutions	More effective application of research results and ideas in the business world	Publicly financed activities should contribute to creating products and services for export	Public sector services should be performed more efficiently and innovatively	Develop effective transport and logistics systems	Promote positive attitudes to business enterprise	Develop work organisations that promote renewal
Promote lifelong learning	Increase interaction between research, industry and the public sector	Promote Swedish companies' business establishment in strategically important markets	Develop support for product development and design	Increase financing in the early stages of business and corporate development	Utilise the industrial and technological potential in the fields of defence and security for civil applications	Develop new solutions to meet new social needs	Increase mobility within and between local labour market regions	Ensure that there are simple and practical regulations that make it easier to run a business	Better utilise the skills of all people
Ensure internationally competitive universities and higher education institutions	Promote regional specialisation in combination with national priorities	Promote Sweden's attractiveness as a co-operation partner for research and development	Develop production technology and production systems	Design good rules and promote the use of intellectual property protection	Develop more powerful and demanding public procurement		Develop an IT infrastructure for the future		Increase personal mobility between business and academia, public and private
Stimulate international student and researcher mobility		Attract foreign direct investments and top competence	Stimulate small and medium sized enterprises' investments in R&D	Create competitive conditions that favour the growth of new companies	Develop rules that drive renewal forward				
Continue to invest in research and graduate studies		Ensure an internationally competitive corporate tax rate	Promote small and medium sized enterprises' capacity to act in international contexts						
Strengthen industrial research institutes		Develop the image of Sweden as a country of innovation							

firms to perform R&D in particular sectors such as defence, space, energy and, formerly, telecommunications.

The intention behind the White Paper's policy mix framework was that it would inform the development and implementation of future policy instruments. This translation process commenced in 2005 with the publication of a Government Bill entitled 'Research for a Better Life'. This announced measures designed to increase investment in R&D, improve its quality and concentrate efforts in key areas likely to lead to social development and business growth. Appropriations to universities for postgraduate education and research were increased, as were appropriations to the Research Councils, and R&D funding allocations were increased in the strategically important areas of medicine, technology and environment and sustainable development. Funding was also increased for the development of critical masses in key centres of excellence. In terms of linkages, initiatives designed to improve the transfer of knowledge between academia and industry were also announced. These included holding companies at universities, cooperative R&D programmes, greater R&D support for SMEs and long-term strategic funding for industrial research institutes.

Traditionally, the spheres of R&D and innovation had been handled separately within the Swedish system of governance, but the White Paper was developed jointly by the Ministry for Education, Science and Culture and the Ministry for Industry, Employment and Communication. This represented a shift towards a more coordinated and integrated approach to policy development in these spheres. A parallel opportunity to establish a permanent body responsible for the coordination of policies across the whole R&D and innovation system, however, was not grasped. An Innovation Policy Council, chaired by the Minister of Industry and Trade, was set up in 2004 to advise on innovation policy matters, but this complemented rather than incorporated the pre-existing Government Research Advisory Board, chaired by the Minister of Education, Science and Culture, which continues to advise on research issues. Both, it should be noted, are responsible for advice, not coordination.

Sweden has a 'veneer' model of governance in which a thin ministerial layer charged with policy formulation is overlaid onto a complex array of agencies responsible for the design and implementation of policy instruments. The main agency supporting the science base, the Swedish Research Council, receives funding from the Ministry of Education, Science and Culture and is responsible for the funding of research across the fields of natural and social sciences, medicine and education. This is primarily response-mode funding to individuals, but funding for groups and institutions is set to increase in the future. Two other Research Councils fund, respectively, research on welfare, the labour market, health and social services (the Swedish Council for Working Life and Social Sciences – FAS – funded by the Ministry of Health and Social Affairs); and research on ecological, conservation, natural resource and construction issues (the Swedish Council for Environment, Agricultural Sciences and Spatial Planning – FORMAS – funded by the Ministry of Sustainable Development and the Ministry of Agriculture, Food and Consumer Affairs. Independent foundations such as the Swedish Foundation for Strategic Research (SSF) also support strategic research in science and engineering.

R&D geared towards industrial needs is supported by Vinnova, constituted in 2001 as the Swedish Agency for Innovation Systems. This receives its funding from the Ministry for Industry, Employment and Communication, but reports in addition to the Minister for Science and Education. Vinnova's activities include funding problem-oriented R&D at universities, often with co-funding from

industry; supporting Competence Centres at universities to encourage long-term collaboration with industry; supporting the development of Industrial Research Centres to assist SMEs; and promoting the development of regional innovation clusters via support for networks and collaborative R&D projects. Vinnova is also involved in other regional development programmes in conjunction with the Invest in Sweden Agency (ISA) and the Swedish Business Development Agency (NUTEK), all of which co-operate with ALMI – the state-owned umbrella organisation for the 21 regional subsidiaries – to develop and support regional growth strategies. In addition, an important new institution, the Innovation Bridge, was constituted in 2005. This handles incubator and seed capital programmes that were formerly the responsibility of Vinnova and builds and complements the work of the Technology Bridge Foundations, set up in 1994 to support the commercialisation of university-based knowledge and co-operation between SMEs and universities.

A bewildering array of other organisations also play a part in the governance and conduct of R&D and innovation-related activities in Sweden's highly developed national and regional innovation systems – too many to cover within the context of a thumbnail sketch of the domain – but one in particular has to be mentioned. The Ministry of Defence contributes the second largest share of annual government funding for R&D after the Ministry of Education and Science. Much of this is performed by the Swedish Defence Research Agency (FOI), but large amounts are also conducted by external firms and universities.

Commentary by the Review Team

Policy Competence

Sweden has one of the most highly developed and successful R&D intensive innovation systems in the world. Its 'problems' are those of maintaining high standards rather than those associated with achieving success or remedying failure, i.e. they are problems that many other countries would willingly exchange for their own. Swedish policymakers have nevertheless recognised that the changing global context in which R&D, innovation, industrial development and trade take place offers both potential opportunities and threats to the way all these activities are supported, conducted and regulated. This sensitivity to changing circumstances has to be congratulated, as does the precautionary wisdom of conducting a comprehensive policy review, especially one adopting an innovation systems perspective and conducted by two of the most important ministries concerned with R&D and innovation.

Informed Response

The review team was also impressed with the analysis underpinning the review and the scope and focus of the policy mix it prescribed. Although the so-called Swedish paradox can probably be explained as a natural consequence of localised investments in R&D leading to non-localised returns in a globalised context, the policy prescription still contained many elements geared towards improving the overall efficiency of the system by strengthening the links between various domains (e.g. between the public sector science base and industry). The threat of loosing footloose R&D capacity also seems to have prompted a shift towards policies capable not only of countering this threat but also of attracting further foreign direct investment. Notable amongst these are the emphases placed on strengthening the human resource and science bases, the attempt to

grow strong regional innovation systems and growth poles and the focus on exploiting the opportunities presented by globalisation.

University Research

Despite successful efforts in recent years to build Competence Centres in universities and to increase the share of Research Council funds available to groups and institutions rather than to individuals, many of the stakeholders interviewed – particularly industry representatives – painted a picture of university research conducted by PhD students under the supervision of individual professors, with little scope for (or interest in) developing the strong, often multi-disciplinary research groups and teams that are characteristic of US (as opposed to European) universities. The increased focus on measures to concentrate resources and build critical masses in universities is thus particularly welcome. The review team noted with interest, however, that the percentage of research income reaching universities direct from the state (42%) is relatively high compared with the amounts received from the state as the result of competitive peer-reviewed processes (35%) and from other non-governmental sources (23%). Direct funding can provide universities with much needed security and autonomy, but it can also foster complacency and have a deleterious effect on quality levels, whereas competition for funds rewards excellence and often helps to improve overall quality. Increasing the share of the competitive funding stream by raising the budgets of the Research Councils and decreasing the share of direct funding is an option that deserves consideration, and the review team was pleased to hear that steps have already been taken in this direction in recent government research bills.

SMEs and Renewal

The focus on renewal via strategies to promote spin-offs and start-ups and support SMEs recognises a key weakness in the Swedish innovation system, commented upon on numerous occasions by various stakeholders during the interviews conducted by the peer review team. One of the suggestions being mooted, namely the setting up of a Small Business Innovation Research initiative, promises to provide a much needed source of funds for SMEs to conduct R&D and a keen incentive for them to develop their own R&D capabilities. This is an option that should be given serious consideration. The emphasis on policies designed to encourage start-ups is also admirable, though many of the discussants during the interview sessions remarked that there might also have to be changes in the tax regime in order to encourage entrepreneurs to continue to grow their companies after the start-up phase. The biggest challenge, however, is to counter many of the risk-averse attitudes in Swedish society and foster an entrepreneurial culture throughout Sweden.

R&D Tax Incentives

The most prominent omission from the R&D and innovation policy mix in Sweden is the absence of any system of R&D tax incentives for either small or large firms. These were common in Sweden until 1982 but have not been used since, though it should be noted that comparatively low corporate income tax levels (28% in 2004) compensate to some degree for their absence. Given the relatively high levels of expenditure of R&D by large R&D intensive companies, the absence of incentive schemes aimed at such performers is understandable. New efforts to encourage SMEs to invest in R&D, however, might warrant a closer look at the potential efficacy of R&D tax incentive schemes. Certainly there is pressure for

such schemes from organisations such as SwedenBio, the Swedish Biotechnology Industry Association.[5]

Industrial Relevance and Access

The efforts to strengthen industrial research institutes and to develop the research institute sector in general are also merited, for the impression gained by the review team was that much remained to be done, first in terms of enhancing the relevance of research in the science base to industrial needs, and second in terms of improving the access of firms, particularly SMEs, to this knowledge base. In particular, the relatively small amount of industry funding for research in universities suggested that the 'third task' mission of universities was not being fulfilled.

Public Procurement

An intriguing emphasis in the White Paper is that placed on the role of public procurement as a means of stimulating R&D and innovation in lead markets. This is a topic being keenly debated across Europe, and the outcomes of the planning discussions now being held in Sweden and their manifestation in terms of concrete policy instruments are keenly anticipated. At the time of the review visit, however, only good intentions were observable.

Boosting Confidence

The gap between intention and implementation raises a number of issues. One concerns the confidence that stakeholders have in the ability of the Swedish system to translate "a good slideshow in the Ministry" into effective actions. Although the review team came across enough evidence to suggest that the White Paper had led to the introduction of some changes and new instruments (witness the contents of the subsequent Government Bill in early 2005), some stakeholders – particularly industry – were more sceptical, arguing that the government had been slow to respond to external pressures for a shift in policy focus[6] and that complacency was not an option. There is scope, therefore, for further reassurance, with actions, as ever, speaking much louder than words.

Ministries and Agencies

Another issue connected with the gap between policy formulation and implementation concerns the respective roles of ministries and agencies. In the Swedish system, ministries provide the policy direction and the agencies are responsible for designing appropriate mechanisms – with the ministries having very little formal say in, or authority over, the form and content of these instruments. In part this accounts for the gap between the publication of policy frameworks and concrete actions. It also explains why some members of the review team, notably those from administrations in which policy formulation and

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[5] Growth Creation by Tax Incentives for R&D - A SwedenBIO Benchmark Study, February 2005. See www.swedenbio.com/upload/Publications/Presentations/R&D%20tax%20incentives_Web_SwedenBIO_050516.pdf

[6] Although the Swedish Government was one of the first to adopt an explicit innovation system approach in the policy formulation process, this only occurred in 2004 despite initial attempts in 1996-7 to involve multiple ministries in the evolution of a "Coordinated Growth Policy".

implementation are the responsibility of single ministries, were surprised at the lack of any firm indications in the White Paper of how policy objectives might be met, what instruments might be deployed, and how they might all interact to alter the dynamics of the Swedish innovation system. In theory, however, the separate roles of Swedish ministries and agencies do not pre-empt the publication of single documents – or the parallel publication of complementary documents – specifying policy frameworks, directions and concrete action plans, as is the case in some other countries. Such a strategy might even soothe some of the more sceptical stakeholders and reassure them that rhetoric is being translated into reality.

Coordination

The separate roles and responsibilities of different ministries and their associated agencies, especially when considered in conjunction with the 'thinness' of the ministerial 'veneer', also raise issues concerning the coordination of policies and policy initiatives. Given the size and complexity of the Swedish innovation system and the number of actors involved in its governance, any attempt at coordination is likely to be extremely onerous.[7] Members of the review team were thus not envious of the task facing lightly staffed ministries. They were also curious as to how activities in the spheres of R&D and innovation might be coordinated given the continued separation of 'horizontal' coordination across ministries, with the Minister for Education, Science and Culture responsible for the coordination of research policy across different ministries (advised by the Government Research Advisory Board), and the Minister for Industry, Employment and Communication responsible for the coordination of industry (and hence innovation) policy across different ministries (advised in this instance by the new Innovation Policy Council). Given that ministries also lack any formal authority to interfere with decisions taken by agencies regarding the application of established laws, the review team was also struck by the potential difficulties associated with 'vertical' coordination between ministries and agencies, and with 'horizontal' coordination between agencies, since the restrictions on the authority of ministries imposes a huge constraint on their ability to coordinate actions, as opposed to policies, across the innovation system. All these issues warrant serious attention given the increasing need to improve coordination in the formulation and delivery of efficient and effective policy mixes. They are also of extreme interest to all nations considering the adoption of a ministry/agency split along Swedish lines.

Vinnova

Vinnova is specifically designated as the Swedish agency for innovation systems. It grew primarily out of NUTEK, the former national agency for industrial and technology development, and its re-branding and reconfiguration in 2000 constituted an explicit recognition of the growing importance of innovation systems thinking within the Swedish policymaking milieu. The commitment of the agency to the concept of innovation systems and to actions likely to improve the Swedish innovation system was also obvious to the review team during its visit. The team was surprised to learn, therefore, that many of the innovation-related activities with which NUTEK was formerly associated did not now fall under the umbrella of Vinnova but had been delegated to other bodies (e.g. the Innovation Bridge and the re-constituted NUTEK), and that its relative sphere of influence had actually shrunk over time. In comparative terms, too, the budget

[7] A major reorganisation in 2000 reduced the number of organisations responsible for the governance of RTD and innovation, but the system is still very complex.

of Vinnova is far less than that of its nearest equivalent in Finland (Tekes). The hidden logic underpinning these decisions may be sound, but the need for effective coordination is obviously increased and the symbolic significance of Vinnova's title correspondingly devalued.

Defence

Given the historical importance of the defence sector in Sweden, the large share of R&D funding it receives from the state and the potential impact that innovation in this sector has had and could have on both defence and civil markets, the peer review team was surprised by the lack of coverage of this issue in the R&D and innovation policy documentation it received. Naturally this might just be a reflection of the limited ground the review team was able to cover, but if it is not then the potential contribution of the defence sector to the future development of the Swedish innovation system deserves further attention. Defence procurement practices may hold valuable lessons for civil practices, and civil and defence strategies within the overall policy mix will need to be coordinated.

Regional Development

Coordination is also an issue in terms of the development of strong regional innovation systems in Sweden. The review team noted and reacted positively to the strong emphasis on strengthening regional capabilities within the White Paper. Once again, however, the sheer number of national and regional bodies with (overlapping?) responsibilities in this sphere gave cause for concern. To some extent this may be inevitable given the nature of regional innovation systems and the range of activities warranting support at this level (i.e. the same set which preoccupies R&D and innovation policymakers at a national level), but the ways in which bodies such as Vinnova, the Innovation Bridge, NUTEK, Invest in Sweden, ALMI and regional authorities themselves interact were not immediately clear to the review team. Again this may be a limitation of the peer review exercise itself, but the impression persisted that there was scope for further clarification of the responsibilities of all the bodies involved in the development of regional innovation systems.

Concentration versus Cohesion

One issue related to regional development that has yet to be confronted properly within the Swedish system is the potential conflict between policies designed to concentrate resources in order to build critical masses and attempts undertaken in the spirit of cohesion to build effective regional innovation systems in multiple settings, which often call for resources to be distributed much more evenly. As one discussant put it, this is "the issue that dare not speak its name". One manifestation of this tension can be found in the university sector. Policies in the recent past have led to a considerable increase in the number of universities across the Swedish regions, all with hopes and aspirations for the future. The White Paper, however, makes it quite clear that efforts in future are likely to focus on the development of a much more limited number of high-performing centres of research (and teaching) excellence, with obvious repercussions for many of the newer universities in the regions and their ability to act as technological growth poles in regional innovation systems. This is an issue that many countries are now having to confront, and there are few indications as to how tensions of this nature will resolve themselves, but they will only do so if

they are faced squarely by policymakers courageous enough to “speak their name”.

Europe

During its mission, the peer review team was struck by the general enthusiasm for EU R&D initiatives such as the EU RTD Framework Programmes and the European Research Council (ERC). Amongst academic research funding organisations, there is support for the ERC on the grounds that its introduction will stimulate excellence within the Swedish university system. Within industry, the Framework RTD Programmes are appreciated by SMEs in particular because they provide a source of direct funding for R&D, while representatives of larger firms emphasised that Swedish participation in some of the key Technology Platforms being established was an imperative for both large and small firms. They also argued that priorities in Sweden had to be consistent with those being developed within the context of the EU RTD Framework Programmes in order for Sweden to remain at the leading edge of both European and global developments. Swedish policymakers would do well to bear in mind the enthusiasm for such alignment during priority setting exercises.

Generic Lessons

Despite its high investment in R&D and sound economic performance, Sweden has still felt the need to adopt an innovation system approach to the development of policies and the formulation of a comprehensive policy mix aimed at improving overall system performance. The dynamics of even the most successful innovation systems are subject to a multitude of both internal and external pressures to which policymakers have to respond. Even when the sea is calm a storm can be brewing, and vigilance is required at all times. Periodic reviews adopting a comprehensive innovation systems approach are increasingly becoming a prerequisite.

Conduct periodic reviews of the dynamics of the national innovation system, the factors affecting overall performance and the policies needed to ensure the continued health of the system.

Phenomena such as globalisation pose both threats and opportunities. Understanding how they might affect the performance of innovation systems by focusing on weak spots in the system is the key not only to countering threats but also to ways of improving system performance and grasping new opportunities. The actions needed in Sweden to prevent the loss of footloose R&D capacity, for example, are often those likely to attract even more foreign direct investment.

> *Prioritise the rectification of weak spots in innovation systems.*

Competition for research funding is often the route to research excellence, while direct state funding of universities allows staff to pursue the autonomous research tracks which are an essential ingredient of the scientific endeavour. A balance between competitive and non-competitive R&D funding is thus often desirable. In Sweden, however, the state funds reaching universities as a result of peer-reviewed processes constitute a comparatively low proportion of overall university research funding (35%) compared to average levels across the EU.

> *Strike a balance between competitive and non-competitive funding which ensures both excellence and academic freedom.*

Sweden has recognised that the continued success of innovations systems in the long term is a function of their capacity for renewal. New firm formation and the subsequent growth of innovative companies are vital ingredients of the renewal process, as are efforts to ensure that SMEs can either access or develop R&D and innovation capabilities. Encouraging all these phenomena, however, typically requires policy actions on many fronts.

> *Ensure that policy prescriptions geared towards renewal via the formation and nurturing of innovative SMEs comprise a mix of instruments tackling, for example, cultural attitudes to entrepreneurship, access to R&D, funding for R&D activities and access to seed capital.*

R&D tax incentives have not been used in Sweden since their use was rejected over 20 years ago. Many other countries use different forms of tax incentive to stimulate R&D activity, but the appropriateness of their use and the likelihood of their success differs from one context to another. New circumstances and changed priorities, however, can demand a re-evaluation of their use. Given Sweden's expressed interest in 'renewal' via the stimulation of R&D and innovation activities in SMEs, it may be time to re-examine the case for targeted R&D tax incentives.

> *When contemplating appropriate policy mixes, consider all options – even those rejected in past situations.*

Research institutes, both public and private, play an important role in many national innovation systems, but not in countries like Sweden where organisations such as universities are expected to act as the primary 'knowledge conduits' between the public and private sectors. Fulfilling this 'third task', however, is never easy for universities given the necessity and importance of their two primary tasks (education and research). Dedicated research institutes constitute an important alternative option.

> *Consider the possibility of dedicated research institutes as a means of helping to bridge the gap between the science base and the R&D and innovation needs of the private sector, particularly SMEs.*

Like a number of other countries, Sweden has shown a renewed interest in technology procurement schemes. In the past these have been a mixed blessing, leading to the existence of strong and successful relationships between technology suppliers and government agencies in some countries, but to far less symbiotic relationships in others. If applied with care, however, they can link supply with demand and stimulate the development of lead markets in critical techno-economic areas.

> *Seek to complement supply side policies aimed at increasing public sector investment in R&D with demand side policies and procurement mechanisms linking supply and demand.*

In Sweden, it is common practice for policy intentions and directions to be announced via government papers and bills, with agencies subsequently left to develop ways of implementing these plans. In practice, however, lengthy gaps between policy pronouncements and subsequent actions can try the patience of stakeholders keen to see governments tackle critical problems. Innovation systems function well when stakeholders have confidence in the competence of policy actors and their ability to act quickly and effectively. Large gaps between statements of intent on the part of policymakers and subsequent actions can undermine this confidence.

> *Ensure that policy pronouncements are quickly matched by concrete implementation strategies and actions.*

Governance systems that split ministry and agency functions, as is the case in Sweden, require mechanisms capable of ensuring horizontal coordination between ministries and vertical coordination between ministries and agencies. Horizontal coordination between different ministries is an important prerequisite for the successful formulation of appropriate policy mixes, while vertical coordination is needed to ensure effective implementation. The mechanisms needed to ensure adequate levels of communication and coordination, however, are often complex and difficult to maintain. In Sweden, for example, one ministry is responsible for the 'horizontal' coordination of research policy across ministries while another is responsible for the coordination of industrial innovation policy, and vertical coordination is limited to some extent by the lack of any formal ministerial authority over the courses of action determined by agencies. In addition, small ministerial staffing levels make the task of ensuring adequate coordination extremely onerous.

In complex innovation systems requiring complex coordination structures, ensure that sufficient resources are devoted to their efficient operation.

For many good and obvious reasons, defence policies are typically considered separately from civil policies. In reality, however, there is often interaction between the civil and defence sectors in terms of the development of dual use technologies and the crossover mobility of scientists, engineers and researchers. Such interactions can be synergistic and in the interests of both sectors, and policymakers should take them into account when formulating holistic policy mixes, especially when the resources devoted to R&D and innovation in the defence sector constitute a large share of national budgets, as is the case in Sweden.

Consider the interaction of civil and defence sectors when formulating holistic policy mixes.

There is a strong emphasis in Sweden on regional development but a confusing array of actors and initiatives and no clear, publicly available overview of how regional and national development strategies are linked. When many different national and regional support bodies are involved in the development of regional innovation strategies, the potential for synergy is obvious, but so too is the potential for duplication and confusion.

Ensure mechanisms are in place to clarify the roles played by different bodies in the development of regional innovation strategies in order to avoid duplication and maximise synergy.

The recent expansion of the university system in Sweden probably raised expectations concerning a more equitable distribution of research funding across the system. Recent policy pronouncements, however, suggest the need to concentrate funding. Prioritisation involving the concentration of resources on particular institutions, sectors or regions is often necessary in order to establish critical masses and viable innovation systems. The flip side of concentration, however, is that the share allocated to other institutions, sectors and regions is correspondingly less. This can lead to tensions and conflicts unless steps are taken to defuse or resolve them.

Explaining the rationale for prioritisation decisions in an open and transparent way can help defuse tensions and lead to the discussion of alternative development paths.

The R&D and innovation priorities being set within an EU framework increasingly represent the priorities of all major academic and industrial players in Europe, many of whom compete successfully in global markets. Alignment of national priorities with EU priorities – for which there is considerable support amongst Swedish academic and industrial stakeholders – is thus one way of assuring that national actors remain in touch with leading edge developments across the world.

> *Take external as well as internal considerations into account when developing national R&D and innovation priorities.*

Appendix 1

Policy Mix Peer Review Team: Sweden

Review Team for Policy Mix Interviews

Sweden 8-10 June

Policy Mix Working Group Representatives

Pierre-Paul Baskevitch, Ministry of Education, France
Sigrid Johanisse, Ministry of Economic Affairs, Netherlands
Patrick Robinson, Department of Trade and Industry, UK
Lauri Tammiste, Ministry of Economic Affairs and Communications, Estonia

European Commission Representatives

Andries Brandsma, IPTS, Seville
Henry Varga, European Commission, DG Research, Brussels

Independent Consultant

Ken Guy, Wise Guys Ltd, UK

Swedish Members of Policy Mix Working Group

Ann-Katrin Berglund, Ministry of Industry, Employment and Communications, Sweden
Susanne Moberg, Ministry of Education, Research and Culture, Sweden

Feedback Mission

Sweden 1 September

Pierre-Paul Baskevitch, Ministry of Education, France
Sigrid Johannisse, Ministry of Economic Affairs, Netherlands
Patrick Robinson, Department of Trade and Industry, UK
Ken Guy, Wise Guys Ltd, UK

Appendix 2

Policy Mix Peer Review Schedule: Sweden

Programme for Policy Mix Interviews

Sweden

Date/Time	Location	Focus	Participants
8 June, Review Mission to Sweden			
10.30-10.45	Ministry of Education, Research and Culture	Welcome and introduction to the programme	Ann-Katrin Berglund, Susanne Moberg, Members of Policy Mix Group
10.45-13.00	Ministry of Education, Research and Culture	Preparations and sandwiches	Peer Review Team
13.00-13.45	Ministry of Education, Research and Culture	Statistics about Swedish Research	Mats Johnsson, Senior Advisor, Ministry of Education, Research and Culture.
13.45-15.00	Ministry of Education, Research and Culture	The Swedish research system and Swedish research policy	Mariann Samuelson, Director, Division for Research Policy, Ministry of Education, Research and Culture.
15.00-16.00	Ministry of Education, Research and Culture	Recent developments in innovation policy	Gunnar Blomkvist, Director, and Linda Sterner, Head of Section, Coordination Secretariat, Ministry of Industry, Employment and Communications.
16.00-17.00	Ministry of Education, Research and Culture	Priorities in FORMAS research funding	Lisa Sennerby Forsse, PhD, Secretary General of the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS)
9 June, Review Mission to Sweden			
08.30-09.30	Ministry of Education, Research and Culture	Priorities in the Swedish Research Council's research funding	Pär Omling, Director General, Swedish Research Council
09.30-10.15	Ministry of Education, Research and Culture	Priorities in FAS research funding.	Rune Åberg, Secretary General, and Erland Bergman, Administrative Director, Swedish Research Council for Working Life and Social Research (FAS).
10.30-11.30	Ministry of Education, Research and Culture	Mission and priorities of the Swedish Foundation for Strategic Research	Staffan Normark, Executive Director, Swedish Foundation for Strategic Research
11.40-12.50	Restaurant	Lunch	Peter Strömbäck, Director, Division for Information Technology, Research and Development, Ministry of Industry, Employment and Communications, and Mariann Samuelson, Director, Division for Research Policy, Ministry of Education, Research and Culture

13.00-14.30	Ministry of Industry, Employment and Communications	Industry's views on research and innovation policy.	Carl Bennet, Chairman of the Board, Getinge and Elanders; Hans Henzell, Executive Director ACREO; Thomas Johannesson, Executive Director, STFI Packforsk; Gösta Jonsson, Vice President, Global Discovery Affairs, Astra Zeneca; Ulf Pehrsson, Vice President, Public Affairs, Ericsson; Lars-Göran Rosengren, President, Volvo Technology; Thomas Sätmark, Vice President Corporate Affairs, Volvo Aero Corporation
15.00-16.00	Ministry of Industry, Employment and Communications	Results from recent studies (distributed before the meeting)	Hans Löf, Royal Institute of Technology, Centre of Excellence for Studies in Innovation and Science and Pär Hansson, FIEF, Trade Union Institute for Economic Research
10 June, Review Mission to Sweden			
09.00-09.30	Vinnova	Guided tour of Vinnova	Leif Callenholm, Director, Head of Administration Division, Swedish Agency for Innovation Systems (Vinnova)
09.30-10.30	Vinnova	Priorities in Vinnova's research funding.	Per Eriksson, Director General, Swedish Agency for Innovation Systems (Vinnova)
11.00-11.45	Ministry of Industry, Employment and Communications	Development of innovation policy in Sweden	Sven-Eric Söder, State Secretary of the Minister of Industry and of the Minister of Research in questions concerning business enterprise development, state-owned companies, primary industries, competition and research and development.
12.00-12.30	Ministry of Industry, Employment and Communications	Preliminary summing-up, plus arrangements for later interview with State Secretary Kerstin Eliasson, responsible for research policy	Susanne Moberg, Ann-Katrin Berglund, Members of Policy Mix Group
September 1, Feed-back Mission to Sweden			
15.00-16.30	Ministry of Education, Research and Culture	Swedish research and innovation policies	Kerstin Eliasson, State Secretary of the Minister for Education, Research and Culture.

Appendix 3

Policy Mix Peer Review Background Report: Sweden

IPTS

December 2005

Policy Mix Peer Review

Background Report[1]

SWEDEN

June 2005 – Updated December 2005

Introduction

Sweden is one of the first three CREST members that volunteered to have their policies directed at achieving the Barcelona targets reviewed. This policy mix peer review exercise is part of the Lisbon process. It follows the open method of co-ordination (OMC).

Background material has been provided by JRC-IPTS, adopting a template proposed to and discussed by the peer review group of CREST members, led by the Netherlands and the United Kingdom. The information has been checked by the country under review.

Sweden is a small, highly open, advanced economy. Although it is physically one of the largest countries in Europe, is has a small population (just about nine million people), yet enjoys very high per capita income. In part this reflects the long-term effects of a significant resource base, particularly in timber and metallic ores, but it also rests on sustained output and productivity growth across a range of economic activities. The substantial industries based on ferrous and non-ferrous ores and timber have declined sharply in importance since the 1970s, but they have had a longer-term impact by leading to the creation of downstream industries and enterprises, and to supply industries for capital and intermediate goods. Out of these industries, much of the contemporary Swedish industrial economy has evolved.

Like other OECD economies Sweden has developed towards a greater share of services in GDP, both public and private, over the long run. But it retains a large industrial sector – in fact larger as a share of GDP than most comparable economies, and unusually for Europe the share of the industrial sector actually increased during the 1990s.

Within manufacturing, the key feature of Sweden is the large size of the engineering sectors: fabricated metal products, machinery, transport equipment and so on. Historically these have been large fields of specialisation for Sweden, with major companies in vehicles, industrial machinery, telecommunications equipment and so

[1] This is the input for Part A of the report on Sweden's policy mix, provided by JRC-IPTS in collaboration with DG RTD-M1. Welcome updates, additions and corrections have been provided by Ann-Katrin Berglund and Susanne Moberg, the Swedish representatives in the CREST-OMC Policy Mix Group of experts. The information was put together on the basis of a template prepared for and agreed by the CREST-OMC Policy Mix Group of experts.

on. These engineering or engineering-related sectors (basically ISIC 38) account for nearly half of all Swedish manufacturing. A key distinctive feature of the Swedish economy is the existence of a significant number of multinational companies: Ericsson, Saab, Electrolux, Volvo, Astra (now part of AstraZeneca), ABB, etc. This is unique for such a relatively small economy. A significant part of Swedish industrial R&D is concentrated in these companies, and they play a role in shaping policy mix issues.

The 'Policy Mix' Issue and the 'Swedish Paradox'

In key respects the idea of a 'policy mix' is central both to understanding Swedish development, and also to understanding its current situation. In the past, the Swedish state has played an active role in economic development, and policies in such fields as industry creation, labour market, education and welfare have been seen in a more coordinated way than in many other countries. At the present time there is a conscious effort to integrate key policy fields in Sweden, particularly with respect to research and innovation. This attempt to coordinate a mix of policies is seen in part as an attempt to confront a structural problem in Sweden, which will be discussed in this note.

The combination of high investment in R&D and low pay-offs in terms of economic growth has given rise to a major debate on the 'Swedish paradox'.[2] There are several explanations on offer for this paradox. The ones which appear to have inspired some key policy changes in the recent past are that the Swedish innovation system is ineffective and that the interplay between university, companies and politics is too weak.

In Spring 2002, in part as a response to the 'Swedish paradox' issues presented above, the Minister of Industry and Trade and the Minister of Education and Science invited representatives from academia, industry, state agencies and unions to policy discussions under the theme "Collaboration for innovation". At these meetings and also since then the "Swedish paradox" has been increasingly put into question, and the focus has moved to how renewal can contribute to growth and how it can be encouraged by the government.

Science Base (R&D Capacity and Performance)

The central point about Sweden's R&D capacity is that its overall R&D intensity is the highest in the OECD: it is significantly above the OECD average, and this applies not only to gross expenditure on R&D (GERD) but also to the business and the university sectors. Although slightly declining, private sector expenditure on R&D is around 3% of GDP. Public sector expenditure is increasing and the target level is 1% of GDP. Direct public funding of R&D by the Government is to be raised from SEK 25.3 billion in 2004 to 26.1 bn in the Government budget for 2005 (the exchange rate is 9.1 Swedish krone to the euro). This includes SEK 1.5 bn from public foundations. The bulk of public funding goes to universities, either directly or through the research councils.

[2] There is a detailed discussion in Edquist, C. 2002. *Innovationspolitik för Sverige: Mål, skäl, problem och åtgärder*. Stockholm: Vinnova.

The high level of academic R&D in Sweden may be partially explained by institutional factors.[3] OECD countries differ significantly in terms of the organisational structure of research. In most countries there is a combination of universities and research institutes that perform diverse functions – not only basic and applied R&D, but also technical functions such as testing, monitoring of equipment, measurement and calibration, etc. These are often carried out by research institutes. But in Sweden this institute sector is small, and its functions are typically fulfilled by the major engineering universities (such as Chalmers in Gothenburg, and KTH in Stockholm). So it can be argued that Swedish academic R&D tends to include a wide range of technical activities that are not included in the academic sector (or even as R&D) in other countries.

	Romania	Spain	Sweden	EU 15	EU 25
GERD as a percentage of GDP	0.40	1.11	4.27	2.00	1.95
Industry (% of total)	48	47	72	56	55
Government (% of total)	43	40	21	34	35
Abroad (% of total)	8	8	3	8	8
Others (% of total)	1	5	4	2	2
SE graduates (% of 20-29 years age class)	9.4	11.3	12.4	11.3	..
Total R&D personnel as % of active population	0.33	1.18	2.43	1.39	..
HRST-core as a % of active population	10	17	23	17	16
Scientific publications per million population	1198	310	940	462	..

Governance

In 2001 the structure of state agencies working with research policy was changed. A number of smaller research boards were merged into four agencies: the Swedish Research Council (Vetenskapsrådet), the Swedish Research Council for Working Life and Social Research (FAS), the Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS) and the Swedish Agency for Innovation Systems (Vinnova). This change was a step towards promoting more competition between research actors and research areas for government funds, as more money channelled through the research boards instead of going directly to universities.

These developments reflect the emergence of a new objective for policy governance, namely integration. A recent White Paper, *Innovative Sweden: A Strategy for Growth through Renewal* (Ds2004:36) sets this governance shift inside a conceptual framework based on the innovation systems concept, and the 'clusters' concept. The innovation systems approach rests on the idea that the system 'can be described in terms of important actors and components such as universities, colleges, institutes, large and small enterprises, venture capital and regulatory frameworks'.[4] Clusters are seen as interdependent activities resting on 'relationships between individual working

[3] For an example of this argument, see Staffan Jackobsson and Annika Rickne, 'How large is the Swedish 'academic" sector really? A critical analysis of the use of science and technology indicators', *Research Policy*, 33 (2004), 1355-1372.

[4] Innovative Sweden: A Strategy for Growth through Renewal (Ds2004:36), p.21

in companies in different branches, between related companies and their customers, but also between companies and research institutes, trade organisations, actors in the public sector etc.'[5] These approaches imply a more coordinated governance system, and this has become an important feature of recent developments in Sweden. The measures for implementing the White paper "*Innovative Sweden*" will be presented gradually on multiple occasions as the degree of preparation needed varies. So far implementation involves:

- Some of the measures in the recently presented Government Bill 2004/05: 80, Research for a Better Life (http://www.sweden.gov.se/sb/d/5032/a/41273)
- The creation of the "Innovation Bridge"
- Discussions with some industries vital to Sweden initiated in the Statement of Government Policy in September 2004 by the Prime Minister. Discussions with IT/Telecom, biotechnology/pharmaceutical, wood/forestry, metallurgic and vehicle industries are in progress.

At the same time as the White Paper was presented, the Government appointed an innovation policy council as a forum for dialogue based on the innovation strategy, chaired by the Minister of Industry and Trade. Research policy issues will, as before, be discussed in the Government Research Advisory Board, which is chaired by the Minister of Education and Science. Both these are strictly advisory, and consist of representatives from academia and industry.

Policy objectives

The White Paper noted above was developed by the Ministry for Industry and Trade and the Ministry for Education and Science as a joint R&D/innovation strategy to strengthen Sweden's innovative capacity. It aims to develop instruments to support greater co-ordination between national policy and the Lisbon Strategy. An important government bill has also been presented: Government Bill 2004/05: 80, Research for a Better Life. The White Paper and the Bill form the basis of current policy.

The basis of the White Paper is an analysis that recognises Sweden's current strengths (high R&D inputs, a highly skilled labour force, a skilled public sector and a diversified business sector) but argues the need to address four major areas of change. These are globalisation, increasing knowledge intensity, environmental sustainability, and demographic ageing. Against this background, the White Paper argues for a focus on four priority action areas. These are, 'Knowledge Bases for Innovation', 'Innovative Trade and Industry', 'Innovative Public Investment' and 'Innovative People'. The specific contents of these policy areas are described in more detail in a later section.

The Government Bill *Research for a Better Life* (2004/05:80) is not a simple reflection of the White Paper. It focuses specifically on R&D policy issues. More funds will be devoted to priority areas in the period 2005-2008. The areas proposed are:

- Three priority research areas: medicine, technology and environment

[5] Ibid., 21

- Improved research training and career opportunities for young/new researchers. This is to offset the ageing of the population of researchers and university staff but also to make better use of the expanded number of research students.
- Enhanced knowledge transfer operations between academia and industry
- Research infrastructures
- Increased investment in industrial design and design research
- A new organisation for EU research cooperation

Policy Instruments
The main instruments through which R&D policy is effected and financed are block grants to universities, and funding of basic and applied research by three research councils and one agency. The research councils support programmes within their areas. They are:

- The Swedish Research Council, responsible for basic sciences across humanities and social sciences, natural and engineering sciences and medicine, and education.
- The Swedish Council for Working Life and Social Sciences (FAS), which funds research on welfare, the labour market, health and social services.
- The Swedish Council for Environment, Agricultural Sciences and Spatial Planning (FORMAS), which is responsible for ecological, conservation, natural resource and construction issues.

In addition there is an agency, reflecting the emphasis on innovation issues and the innovation system:

- The Swedish Agency for Innovation Systems (Vinnova). This agency support innovation-oriented R&D in such fields as engineering, transportation, communications and the labour market. Until 2005 it also included incubator systems supporting start-ups, but when the Innovation Bridge was created in 2005, these issues were moved there.

Business R&D and Innovation (technological and innovation performance)

Some 40 out of the 500 companies in the EU that spend most on R&D are based in Sweden, according to the 2004 EU industrial R&D investment scoreboard compiled by the Commission services (DG Joint Research Centre, DG Research). They account for 6.4% of the total spending by these 500 companies, of which the largest part is in the sector of IT hardware (in which Ericsson is second to Nokia) and in engineering and machinery (Volvo, Scania, Sandvik, Atlas Copco are in the EU top 10 in this sector). These are the two sectors in which business expenditure on R&D as a percentage of the total in Sweden is more than 10 percentage points higher than the EU average (OECD, 2004). The Scoreboard shows that Swedish companies are also strong in some other sectors: Electrolux is the biggest spender on R&D in the EU in the sector of household goods and textiles. AstraZeneca and ABB are high on the overall list as well, with headquarters are registered in the UK and Switzerland, respectively (and therefore not included in the 40 above).

Patenting is well above the EU average in terms of absolute numbers (Sweden ranks 8th in the world) and growth rate (where Sweden is among the five fastest growing EU countries in terms of patenting in the EU).

In *The Competitive Advantage of Nations*, Michael Porter listed more than fifty industries where Sweden had a share of world trade greater than 6%. Sweden is an economy with a strong history of industry building, and the industrial structure reflects that history. Over the past decade there has been one major structural shift in manufacturing, with important implications for innovation in Sweden. This is the success of Ericsson in mobile telephone, both handsets and infrastructure. Ericsson is the world leader in base station infrastructure (a lead that has its roots in earlier digitalisation of telecommunications), and this has had powerful effects on research and training in electronics in Sweden.

Indicators and Challenges

The key point concerning industrial R&D indicators is the strong R&D intensity of the business sector.

Table 1: Expenditures on innovation as proportion of turnover, various countries, 1997

		Size-classes		
Country	**Manufacturing sector, total**	**Small**	**Medium**	**Large**
Belgium	2.2	1.5	1.2	2.6
Germany	4.1	3.3	2.4	4.7
Spain	1.8	1.0	1.6	2.2
France	3.9	1.4	2.2	4.8
Ireland	3.3	2.8	3.2	3.7
Netherlands	3.8	3.0	1.8	4.6
Austria	3.5	4.4	3.1	3.5
Finland	4.3	1.6	1.6	5.1
Sweden	7.0	2.6	2.7	8.2
UK	3.2	3.3	2.9	3.2
Norway	2.7	2.2	2.8	2.8
TOTAL	*3.8*	*2.3*	*2.3*	*4.4*

Source: CIS-2, summary tables, Eurostat.

One approach to this suggests that the explanation lies in a closer understanding of the data and indicators. On the industry side, the idea is that higher industry R&D is a consequence of the fact that Sweden (as noted above) has a strong sector of global MNCs. These companies perform their key R&D in Sweden, but utilise it in their worldwide operations – so effects are not directly visible in Sweden.

The *Community Innovation Survey* section looks at Swedish expenditures on important non-R&D expenditures such as design, training, tooling up, capital investment linked to new product introduction, and so on. The CIS data must be treated with some caution, but it can be noted that Sweden's profile differs than other European countries, particularly in the size class of larger firms.

On the output side, external patent applications rose sharply during the 1990s. However innovation output performance does not necessarily match the strong input side. *Community Innovation Survey* data on general new product sales suggests that while Sweden does as well or slightly better than most of its European partners, its commitments of R&D and non-R&D are not reflected in particularly high scores on innovation indicators. Table 2 shows some data from CIS-2 on all sales of new and improved products across sectors and firm-size categories. Sweden performs well in one sector, machinery and electrical equipment (NACE 29-33), but is not notably better than other EU countries across other industries.

Table 2: Turnover of new or improved products in manufacturing by country, NACE and size-class. Percentage of total turnover. 2000

CODES	BREAKDOWN	B (2)	D	E	F	IRL	NL (3)	A	FIN	S
Size-class	Small	14	43	27	21	32	25	31	25	31
20-49	Small	7	30	9	8	21	15	29	6	11
50-249	Medium-sized	10	31	16	14	26	20	20	13	22
250 +	Large	16	47	37	25	43	28	37	28	34
NACE										
15-19	Food products; beverages and tobacco;Textiles and leather	8	27	15	8	12	20	23	11	16
20-22	Wood;pulp and paper;publishing	5	16	13	12	20	15	26	10	16
23-26	Coke;chemicals;rubber and plastic;other non-metallic minerals	15	38	26	20	25	29	25	19	19
27-28	Basic metals and fabricated metal products	10	24	17	13	26	14	28	12	19
29-33	Machinery and equipment NEC;Electrical and optical equipment	32	54	42	36	69	40	47	54	51
34-37	Transport equipment and manufacturing NEC	14	62	46	28	22	28	38	27	39

n.a. : Non available

(2) : Preliminary results

(3) : In NL, medium-sized is defined as 50 to 199 and large as more than 200 employees.

Source: CIS2 Results, Eurostat

Governance

One of the major issues in Swedish policy development has been a somewhat unique system of corporate governance in the industrial sector. As noted above, Swedish industrial performance is led by a group of global-level companies, and this pervasiveness of strong firms is a feature of Sweden that is unique among small economies. These companies are in turn controlled via a distinctive governance system, resting on family and/or bank-based closed-end investment companies that play an active role in development and implementation of company strategies.

This long-standing system of corporate governance has changed somewhat during the past decade, as the result of policy-driven governance changes. There have been three important developments. First, from the 1990s there has been a significant political challenge to the Social Democrats with the critique of social democracy focusing on the viability of the welfare system and on challenges of economic growth in the context of rapid technological change. This has fed into debates on corporate governance. Second, as with other OECD economies, the combined effects of capital market liberalisation, which dramatically increased stock market activity, and of

partial or complete privatisations have led to shifts in the structure of ownership, finance and control. Some of the implications of these changes are as yet far from clear.

The major policy initiatives related to business-sector governance lie in deregulation and liberalisation processes. Deregulation has actually been underway in Sweden for many years, and it is in many ways a pioneer of liberalisation. For example, Sweden was one of the first countries in Europe to reform its telecommunications regime in a liberalised direction. But Sweden was also one of the first countries to implement competitive regimes in energy and transport markets, and it has also liberalised postal services. In terms of the business climate there has been a substantial simplification of tax rules and corporate taxation, and a simplification of regulation for SMEs. This broad governance shift has gone a long way in Sweden, which is very far from being the controlled and regulated welfare state which it is sometimes depicted as.

Policy Objectives

The main policy objectives relating to innovation are gathered in the recent *White Paper*. Some of the challenges, targets and analyses have earlier been presented in different Government bills. They are:

- *Knowledge Bases for Innovation.* Here the argument is for two areas of activity. First, education: continuing attention to all levels of education from pre-school to university, with improvement of vocational training and a target of 50% of children born in any particular year undertaking university-level studies by the age of 25. A strong emphasis on student and researcher mobility is proposed, with expanded research environments and strengthened research institutes. A further aspect of this area is the strengthening of the framework for benefiting from globalisation – expanded language skills, and measures addressing the tax framework as it affects location decisions.
- *Innovative Trade and Industry*. Here the measures address firstly SMEs, proposing to strengthen not merely R&D, but also cooperative networks, product design and development processes, production technologies, and international operations by SMEs. A second area is the improvement of commercialisation.
- *Innovative Public Investment.* Sweden has the highest public consumption as a share of GDP in Europe (indeed in the OECD). The White Paper envisages using this as a driver of innovation, mainly through an enhanced innovation-oriented approach to public procurement and by spin-offs from defence and security applications. This extends into innovation in public services, and – most importantly – into a new innovative approach to infrastructures. Here the challenge is to use Sweden's substantial infrastructure investments as an innovation vehicle.
- *Innovative People.* Here the focus is on two areas: entrepreneurship and skills development. Sweden has a low proportion of persons who have set up new enterprises, relative to other EU countries, and the aim is to overcome this, particularly with changes to the regulatory framework. The second action is to enhance Sweden's already strong skills development programmes, and to encourage greater inter-sectoral mobility.

Policy Instruments

The principal agency with respect to industrial R&D and innovation is VINNOVA. Its primary instruments are research project funding. Examples of programmes are:

- Programmes for research, development and demonstration. Activities oriented towards mission-oriented research fall mainly under this umbrella.
- Competence Centres and VINN Excellence Centres programs. The aim is to create internationally recognised environments for academic and industrially relevant research and to build academic industry links. In 2004, Vinnova launched the next generation of Competence Centres, the "Vinn Excellence Centres"
- VINNVÄXT – regional growth through development of dynamic innovation systems.

These programme instruments are focused around 18 'growth areas' which VINNOVA regards as central for future growth. These areas have a number of important 'policy mix' implications: they are often interdisciplinary, and seek to integrate industrial objectives and socio-economic dimensions. The growth areas are:

- Telecom systems
- Micro- and nanoelectronics
- Software products
- E-services in public administration
- IT in home healthcare
- The experience industry
- Pharmaceuticals and diagnostics
- Biotech supply
- Biomedical engineering
- Innovation in foods
- Complex and assembled products
- Wood manufacturing
- Intelligent and functional packaging
- Light materials and lightweight design
- Materials design, including nanomaterials
- Green materials from renewable resources
- Innovative vehicles for different transport modes
- Innovative logistics and freight transport systems

This set of fields is notable because it extends well beyond the simple set of priorities that characterise most public RTD systems. It should be noted that several of them are ambitious attempts to upgrade the technological and knowledge bases of quite traditional areas of low tech or medium tech manufactures (such as food, wood products and packaging).

The growth areas are further supported by five 'knowledge platforms' that focus on the generic knowledge that underpins the growth areas. It is here that the main attempts to integrate academic research are found. The knowledge platforms are:

- Biotechnology
- Efficient product development

- Learning and health in working life
- ICT implementation
- Infrastructure and efficient transport systems

Economic and Market Development (Absorptive Capacity)

Sweden is a highly developed market economy. The experience industry – one of VINNOVA's 18 'growth areas' – is the fastest growing sector. IT developments are enhancing the market potential for entertainment products and services, focussing on consumer experience.

Indicators and Challenges
For such a highly developed market it is not surprising to find that sales of 'new to market' products is at the EU average. At the same time, it is interesting that sales of 'new to firm' products as a percentage of turnover are 5 points higher than the EU-15 average. This seems to be a consequence of product development and diversification in Swedish MNCs.

Internet access in Sweden is almost two times more intensive than in the EU-15. On ICT expenditure as a percentage of GDP the country is considerably ahead of the rest of Europe.

	Romania	Spain	Sweden	EU 15
Internet access/use	0.10	0.25	0.97	0.51
ICT expenditures (% of GDP)	2.2	4.4	9.8	7.0
Labour productivity per hour worked relative to EU 15 (EU 15 = 100)	..	87.2	96.5	100.0

Governance
A key feature of Sweden's economy has been the strong hand of the state in industrial development. This has come through state agencies such as Televerket (the state telecommunications agency, which facilitated Ericsson's entry into the market for mobile phones, but also in the form of a strongly independent defence policy. Although this effort has declined in the past decade, major defence procurements can be seen to have had very significant effects on industrial capabilities (Edquist and Lundvall, 1992).

Deregulation and liberalisation have moved Sweden away from industrial policy. The country is very open to international trade and foreign investment. However, there appear to be some worries among industrialists that the Government is unable to give a clear direction to research funding. They generally welcome Sweden's integration into the European single market and expect more from the EU. For instance, the European Patent is high on their list.

Human Resources (Human and Social Capacity)

Sweden has, for a long historical period, had a strong basis of educational attainment. From the late 18th century Sweden had very high levels of literacy among all sections of the population, including especially women, and economic historians have often

argued that this underlies Sweden's spectacular growth record from the mid-19th century.

The "Scandinavian model" is based on high levels of taxation and social benefits, together with relatively compressed wage and income structures. Whereas labour market participation is high, Sweden's unemployment rates are relatively low and long-term unemployment (longer than 12 months) is the lowest in the EU.

	Romania	Spain	Sweden	EU 15
Public expenditure on education as a percentage of GDP	3.3	4.4	7.3	5.1
Population with tertiary education (% of 25-64 years age class)	10.0	24.4	26.4	21.5
Participation in life-long learning (% of 25-64 years age class)	1.1	5.0	18.4	8.4
Employment in medium-high and high-tech manufacturing (% of total workforce)	5.5	5.4	7.3	7.4
Employment in high-tech services (% of total workforce)	1.6	2.5	5.2	3.6

Indicators and Challenges

This strong educational performance is now a characteristic feature of Sweden. Sweden ranks sixth in the OECD in terms of the percentage of the 25-34 year old population with tertiary education: approximately 40 percent of this cohort have tertiary education in Sweden. By field of study, Sweden has a significantly higher proportion of students in engineering, manufacturing and construction than the OECD average and only a slightly lower percentage in life sciences and computing. Sweden has two very strong engineering universities, and there has been strong demand for engineering training at university level over the past decade. In terms of skills, Sweden has the third highest proportion of employment in the broad ICT sector in the OECD. It has the second highest level of worker training in the OECD, with 61% of workers participating in training.[6]

Just as Sweden leads in R&D expenditure it also lies close to the OECD top in terms of R&D employment as a share of total employment.

Participation in life long learning as a percentage of the population in working age is nearly 5 points higher than the EU-15 average (of 21.5%).

Governance

Universities play a central role in Swedish R&D, carrying out by far the largest part of publicly funded research. This is the result of a carefully chosen strategy to avoid the scattering of resources and to guarantee the freedom of research, providing a direct link between research and education.

The "Scandinavian model" is based on high levels of taxation and social benefits, together with relatively compressed wage and income structures. Labour market

[6] See OECD, *Developing Highly Skilled Workers: Review of Sweden* (2002); Centre for Higher Education Policy Studies, *Higher Education in Sweden*, October 2002.

participation and live long learning rates are high. Sweden's unemployment rates are relatively low and long-term unemployment (longer than 12 months) is the lowest in the EU.

Policy objectives
In order to maintain both the knowledge base and the high level of welfare in the face of an ageing population Sweden needs to increase training in research and to strengthen its entrepreneurial culture.

Policy instruments
In response to these challenges Sweden has, as other Member States, taken some measures to facilitate access to finance for entrepreneurs and SMEs. The main Government operators in this field are the Swedish Business Development Agency (NUTEK), ALMI Business Partner, the Swedish Industrial Development Fund, the Innovation Bridge and Technology Bridge Foundations and the Norrland Fund.

The tax system is of considerable importance for entrepreneurship and enterprise. As from 1 January 2005 the inheritance and gift tax has been abolished, with the purpose of facilitating the succession of generations in non-listed companies and the transfer of business and knowledge.

	Romania	Spain	Sweden	EU 15
Employment in medium-high and high-tech manufacturing (% of total workforce)	5.5	5.4	7.3	7.4
Employment in high-tech services (% of total workforce)	1.6	2.5	5.2	3.6
Innovation expenditures (% of all turnover in manufacturing/services)	1.4	2.4	7.0	3.7
SMEs innovating in-house (% of manufacturing SMEs and % of services SMEs)	13	17	36	44
SMEs involved in innovation co-operation (% of manufacturing SMEs and % of services SMEs)	3	7	28	11
Share of manufacturing value-added in high-tech sectors	4.8	7	16	14
Sales of ‘new to market’ products (% of turnover in manufacturing and % of turnover in services)	8	10	7	7
Sales of ‘new to the firm but not new to the market’ products (% of turnover in manufacturing and % of turnover in services)	2	26	24	19

Overall Innovation System

Any assessment of the policy mix issue in Sweden should probably begin with the diagnosis of the problem which is current both in government and among analysts. This diagnosis is that the innovation system fails to convert strong inputs into equivalent outputs, and that there is therefore a ‘paradox’ in the system.

The ‘paradox’ approach has two dimensions. Firstly there is the statistical record, which suggests a gap between innovation inputs and growth outputs. Second, there is a related argument, that high R&D has not led to a strong high-tech sector in Sweden (Edquist and McKelvey).

In the first place there is a conceptual issue, of whether R&D expenditures ought to be seen in any simple way as producers of innovation outputs. Many analysts and policymakers reject the so-called ‘linear model’ of innovation, in which acts of discovery (usually in the research system) are held to be precursors of innovation. Secondly, it is important to note that low and medium tech sectors do benefit from R&D and innovation and have been growing rapidly, especially in the services sector. This is where the Swedish approach of "Research for a Better Life" could have a major impact.

The Swedish innovation system is clearly in a major transition. It has left a phase of industrialisation based on electro-mechanical and engineering products, driven by large companies with tight ownerships that have been closely connected with the state. It has entered a more deregulated and liberalised economy, in which the defence and industrial concerns of the state play a much smaller role. An important question is whether the governance systems that have made Sweden rich remain appropriate. What are the main challenges to Sweden resulting from the transition Sweden is going through? What R&D policies will contribute to keep the R&D rate of industry high?

As the ministries in Sweden are rather small and the implementation of policy is delegated to state agencies, it could also be interesting to look at how national policies are put into practice by the agencies.

Finally, in debating the Swedish ‘paradox’ or its general performance, it seems important to bear in mind the level of economic development in Sweden. Although there may be concerns about growth rates, levels of income and productivity are extremely high. If Sweden has problems, they are issue of maintaining success, not overcoming failure.

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