OECD Reviews of Innovation Policy

SWEDEN

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OECD Reviews of Innovation Policy: Sweden 2012

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Foreword

The OECD Review of Sweden's Innovation Policy is part of a series of OECD country reviews of innovation policy.* It was requested by the Swedish authorities, represented by the Ministry of Enterprise, Energy and Communications and was carried out by the OECD Directorate for Science, Technology and Industry (DSTI) under the auspices of the Committee for Scientific and Technological Policy (CSTP), in collaboration with the Committee for Industry, Innovation and Entrepreneurship (CIIE). The review draws on the results of a series of interviews with major stakeholders of Sweden's innovation system and on a background report commissioned by the Swedish authorities. This background report was prepared by the Swedish Agency for Growth Policy Analysis (referred to as Growth Analysis in this report) under the direction of Dan Hjalmarsson and was authored by Lars Bager-Sjögren and Enrico Deiaco. It contains a broad range of information that is widely drawn upon in this report.

The purpose of this review is to obtain a comprehensive understanding of the key elements, relationships and dynamics that drive the Swedish innovation system and the opportunities to enhance it through government policy. More specifically, the review:

- Provides an independent and comparative assessment of the overall performance of Sweden's National Innovation System (NIS).
- Recommends where improvements can be made within the system.
- Formulates recommendations on how government policies can contribute to such improvements, drawing on the experience of other OECD countries and evidence on innovation processes, systems and policies.

The review is intended to be relevant to a wide range of stakeholders in Sweden, including government officials, entrepreneurs and researchers as well as the general public. It also aims to use the OECD as a communication platform to provide an accessible and comprehensive presentation of the Swedish innovation system and policy to a global audience. Emerging results of the review were presented to the CIIE in April 2012. A draft version of the Overall Assessment and Recommendations, containing key observations and recommendations, was presented at a workshop organised by the Swedish Government and the Forum for Innovation Management (FIM) in Stockholm, and was presented for a peer review to the Working Party for Innovation and Technology Policy (TIP) of the CSTP in June 2012, and to the CSTP in October 2012.

This report was drafted by Michael Keenan (Country Review and Outlook Division [CSO], DSTI, OECD); Alistair Nolan, (Structural Policy Division, DSTI, OECD); Dimitrios Pontikakis (CSO, DSTI, OECD); and Michael Stampfer (consultant to the OECD; Managing Director, Vienna Science and Technology Fund [WWTF], Austria), under the supervision of and with contributions from Gernot Hutschenreiter (CSO, DSTI, OECD). Michael Hofer (formerly WWTF, presently Head, Department of Quality

* *www.oecd.org/sti/innovation/reviews*

Assurance, University of Vienna, Austria), Donia Lasinger (WWTF), and Marie-Louise Bruner (Technical University of Vienna) provided valuable contributions. Ali Eser, Natalie Cooke, and Yingchun Zhu, all working at DSTI at the time of their contribution, provided valuable input, statistical support and web-based research.

The review owes much to the support and co-operation of Swedish government officials, in particular Erik Fahlbeck, Sara Modig and, in the final phase, Marie Ivarsson (Ministry of Enterprise, Energy and Communications and delegates to the CIIE and CSTP, respectively) as well as Katarina Isaksson (Counsellor, Swedish Permanent Delegation to the OECD) in their respective capacities, all of whom provided invaluable support at all stages of the review process. Magnus Jonsson (Ministry of Enterprise, Energy and Communications) provided information, arranged the interviews during the fact-finding mission in Sweden, and supported the OECD review team throughout this process. The report has benefited from comments and additional information received from numerous stakeholders in Sweden, delegates of the CSTP and CIIE, participants in the above-mentioned Stockholm workshop and the TIP peer review – in particular Tricia Berman and Arie van der Zwan who acted as peer reviewers – and distinguished experts in the field.

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Abbreviations and acronyms

AAGR	Average Annual Growth Rate
AB	Stock Company *(Aktiebolaget)*
AE	Adult Education
ALS	Amyotrophic Lateral Sclerosis
BERD	Business Expenditures for Research and Development
BMBF	*Bundesministerium für Bildung und Forschung*
BMVIT	*Bundesministerium für Verkehr, Innovation und Technologie*
BMWF	*Bundesministerium für Wissenschaft und Forschung*
BMWFJ	*Bundesministerium für Wirtschaft, Familie und Jugend*
BRICS	Brazil, the Russian Federation, India, People's Republic of China and South Africa
CC	Competence Centre
CIS	Community Innovation Survey
CIT	Corporate Income Tax
CNRS	*Centre National de la Recherche Scientifique*
CO_2	Carbon Dioxide
CoE	Centre of Excellence
COMET	Competence Centres for Excellent Technologies (Austria)
COST	European Cooperation in Science and Technology
EC	European Commission
EEA	European Economic Area
EIS	European Innovation Scoreboard
EIT	European Institute of Innovation and Technology
EKN	Swedish Export Credit Guarantee Board
EPFL	Swiss Federal Institute of Technology Lausanne *(Ecole Polytéchnique Fédérale Lausanne)*
EPL	Employment Protection Legislation
EPO	European Patent Office
ERA	European Research Area
ERC	European Research Council
ERDF	European Regional Development Fund
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
ESS	European Spallation Source
ETH	Swiss Federal Technical University (*Eidgenössische Technische Hochschule)*
ETHZ	Swiss Federal Institute of Technology Zurich *(Eidgenössische Technische Hochschule Zürich*)

EU	European Union
EUA	European University Association
EUR	Euros
EUREKA	Raising the Competitiveness of European Business through Technology
FAS	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
FDI	Foreign Direct Investment
FFG	Austrian Research Promotion Agency
FFI	*Fordonsstrategisk Forskning och Innovation*
FMV	Swedish Defence Material Administration
FOI	Swedish Defence Research Agency *(Totalförsvarets Forskningsinstitut)*
Formas	Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning
FP	Framework Programme
FTAB	*Fouriertransform AB*
FTE	Full Time Equivalent
FWF	Austrian Science Fund
G20	Group of Twenty Finance Ministers and Central Bank Governors
GBAORD	Government Budget Appropriations for R&D
GDP	Gross Domestic Product
GERD	Gross Expenditures for Research and Development
GNP	Gross National Product
GOVERD	Governmental Intramural Expenditures for Research and Development
GRP	Gross Regional Product
GSM	Global System for Mobile Communication
GTAI	Germany Trade and Invest
GUF	General University Funds
GVC	Global Value Chain
HCR	Highly Cited Researchers
HE	Higher Education
HEI	Higher Education Institute(s)
HERD	Higher Education Expenditures for Research and Development
HGE	High-Growth Enterprise
HR	Human Resources
HRST	Human Resources in Science and Technology
ICT	Information and Communication Technologies
IMF	International Monetary Fund
INV	Institute for Ethnic Studies
IP	Intellectual Property
IPR	Intellectual Property Rights
ISI	Thomson Reuters Web of Knowledge
ISIC	International Standard Industrial Classification of All Economic Activities
ITPS	Swedish Institute for Growth Policy Studies

IUS	Innovation Union Scoreboard
IVA	Royal Swedish Academy of Engineering Sciences *(Kungliga Ingenjörs Vetenskaps Akademien)*
JACP	Junior Achievement Company Programme
JPO	Japan Patent Office
KAW	Knut and Alice Wallenberg Foundation
KBC	Knowledge-based Capital
KIBS	Knowledge-intensive Business Services
KIC	Knowledge and Innovation Community (EIT)
KKS	Knowledge Foundation *(KK-stiftelsen)*
KTH	Royal Institute of Technology *(Kungliga Tekniska Högskolan)*
KVA	Royal Swedish Academy of Sciences *(KungligaVetenskaps Akademien)*
LEED	Local Economic and Employment Development Programme (OECD)
LSO	Network on Data Collection and Development on Economic, Labour Market and Social Outcomes of Education
MD	Medical Doctor
MEPIN	Measure Public Innovation project
MER	Ministry for Education and Research
MFP	Multi-factor Productivity
MISTRA	Foundation for Strategic Environmental Research
MIT	Massachusetts Institute of Technology
MNE	Multinational Enterprise
MSTI	OECD Main Science and Technology Indicators database
NACE	European Classification of Economic Activities *(Nomenclature des Activités Économiques dans la Communauté Européenne)*
NGO	Non-Governmental Organisation
NIS	National Innovation System
NUTEK	Swedish National Board for Industrial and Technical Development *(Närings- och teknikutvecklingsverket)*
NUTS	Nomenclature of Territorial Units for Statistics
NWO	Netherlands Organisation for Scientific Research
OECD	Organisation for Economic Co-operation and Development
OHIM	The Office for Harmonization in the Internal Market
PCT	Patent Cooperation Treaty
PhD	Doctor of Philosophy
PIRLS	Progress in International Reading Literacy Study
PISA	Programme for International Student Assessment
PMR	Product Market Regulation
PPP	Purchasing Power Parity
PQI	Patent Quality Index
PRO/PRI	Public Research Organisation/Institute
R&D	Research and Development

RAE	Research Assessment Exercise
RCA	Revealed Comparative Advantage
REF	Research Excellence Framework
RJ	*Riksbanken Jubileumsfond*
RISE	Research Institutes of Sweden
RITTS	Regional Innovation and Technology Transfer Strategies and Infrastructures
RTDI	Research, Technological Development and Innovation
SBA	Swedish Business Association
SBIR	Small Business Innovation Research
SCB	Statistics Sweden *(Statistiska Centralbyran)*
SEK	Swedish Crowns
SEMCo	Swedish Environmental Management Council
SF	Structural Funds
SICS	Swedish Institute of Computer Science
SIDA	Swedish International Development Cooperation Agency
SISP	Swedish Incubators & Science Parks
SME	Small and Medium Enterprises
SNF	Swiss National Science Foundation
SNSB	Swedish National Space Board *(Rymdstyrlsen)*
SP	Technical Research Institute of Sweden *(Sveriges Tekniska Forskningsinstitut)*
SSE	Stockholm School of Economics
SSES	Stockholm School of Entrepreneurship
SSF	Swedish Foundation for Strategic Research
SSH	Social Sciences and Humanities
STEM	Swedish Energy Agency *(Statens Energimyndigheten)*
STI	Science, Technology and Innovation
STINT	Swedish Foundation for International Co-operation in Research and Higher Education
STU	Swedish Board for Technical Development
SULF	Swedish Association of University Teachers
SVCA	Swedish Venture Capital Association
Swerea	Swedish Research (PRO)
S&E	Science and Engineering
S&T	Science and Technology
TBP	Technology Balance of Payments
TFP	Total Factor Productivity
TFR	Technical Research Council
TIMMS	Trends in International Mathematics and Science Study
TLO	Technology Licensing Office
TNO	Dutch Research and Technology Organisation *(Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek)*
TTO	Technology Transfer Office

UKIIF	United Kingdom Innovation Investment Fund
USD	United States Dollars
USPTO	United States Patent and Trademark Office
VAT	Value-added Tax
VINNOVA	The Swedish Governmental Agency for Innovation Systems
VP	Vice President
VR	Swedish Research Council *(Vetenskapsrådet)*
VTI	Swedish National Road and Transport Institute
VTT	Technical Research Centre of Finland
YEDA	TTO of Weizmann Institute

Country name abbreviations

AUS	Australia	**FIN**	Finland	**MEX**	Mexico
AUT	Austria	**FRA**	France	**NLD**	Netherlands
BEL	Belgium	**GBR**	United Kingdom	**NOR**	Norway
BRA	Brazil	**GRC**	Greece	**NZL**	New Zealand
CAN	Canada	**HUN**	Hungary	**POL**	Poland
CHE	Switzerland	**IND**	India	**PRT**	Portugal
CHL	Chile	**IRL**	Ireland	**RUS**	Russian Federation
CHN	People's Republic of China	**ISL**	Iceland	**SVK**	Slovak Republic
CZE	Czech Republic	**ISR**	Israel	**SVN**	Slovenia
DEU	Germany	**ITA**	Italy	**SWE**	Sweden
DNK	Denmark	**JPN**	Japan	**TUR**	Turkey
ESP	Spain	**KOR**	Korea	**USA**	United States
EST	Estonia	**LUX**	Luxembourg	**ZAF**	South Africa

OECD Reviews of Innovation Policy: Sweden
Overall assessment and recommendations

Sweden's history, cultural and institutional characteristics, and geographical features are important considerations in an assessment of the current state of its innovation system. Its nine million inhabitants can look back at an extraordinarily successful history of economic and social development. It started the industrialisation process as a relatively poor, resource-based country in the mid-19th century and is now an advanced society with a welfare state widely referred to as the "Swedish model". On various counts Sweden ranks among the world's most innovative countries today. It overcame the limitations of a small domestic market through a high degree of internationalisation, not least through the emergence of large Swedish enterprises. Innovation has long been a pillar of Sweden's development, even before innovation was explicitly considered a key driver of economic growth and social development. As this review will argue, innovation is also the key to Sweden's future in a globalised world.

Achievements and challenges: Continuing a highly successful path of socioeconomic development

Sweden started to industrialise in the 19th century and gradually became a strong technological nation. Its development has not been linear, however. Rather, the Swedish innovation system has become what it is today through successive waves of development, each characterised by specific drivers of growth.

A highly successful economic and social development trajectory

Sweden's record of development over more than a century is impressive. As economic historians have noted, from 1850 to 1970 Sweden first caught up with early industrialising countries such as Great Britain, and subsequently begun "forging ahead".[1] From the mid-nineteenth century, the Swedish economy and society were transformed by the introduction of innovative steel processes, modern factories and the construction of railways. This was accompanied by an expansion of exports (mainly agricultural and forestry-based commodities and iron) and of imports of machinery and equipment as well as technological know-how, particularly from Great Britain.

Sweden was then able to participate fully in the second industrial revolution in machinery and engineering, chemicals, and consumption goods. A cohort of knowledge-intensive firms appeared between 1880 and 1910, among them AGA, Asea (ABB), Ericsson, Separator (Alfa Laval) and SKF. As in other countries at the time, such firms were often founded by inventor-entrepreneurs with a background as scientists or engineers. The abundance of hydropower played a crucial role in Sweden's development. From about 1930 "development blocks" evolved around electric (household) equipment, automotives and services (Volvo, Saab, Electrolux to Tetra Pac, IKEA, H&M). The electronics-ICT "development block" gained momentum from around 1970.

Public procurement was a major driver of innovation and economic development for an important part of Sweden's modern history. This is evident in the so-called "development pairs" involving business firms and public/private partners, some of them engaged in very long-term relations, *e.g.* ASEA-Vattenfall for electricity transmission, AXE digital switches and the GSM standard (Ericsson-Televerket), etc. A framework for interaction and co-operation among government and social partners and the sharing of productivity gains as well as high levels of education and skills provided critical pillars.

However, following three decades of post-war prosperity the Swedish economy's trend growth eventually started to slow and productivity growth was sluggish. In the early 1990s Sweden suffered a severe recession and the "Swedish model" came under increasing strain. Together with Sweden's accession to the European Union,[2] this led to institutional changes in areas such as product and capital market liberalisation, wage formation and procurement rules. Investment started to shift from physical goods towards intangibles (such as R&D). Various reforms and adjustments helped turn around Sweden's economic performance in the 1990s, and growth of GDP and productivity accelerated. Sweden then continued on a successful path during most of the first decade of the 21st century. Like other open economies around the world, Sweden was hit by a contraction in external demand during the financial and economic crisis of 2008-09. However, Sweden has shown a high degree of resilience, weathered the crisis better than other countries and rebounded rapidly. Following the recession Sweden's economy has grown significantly faster than that of the OECD area as a whole. Yet Sweden is not insulated from developments in Europe and the wider global economic environment.

Succeeding in a globalised world …

Overall, the "Swedish model" has been remarkably resilient, owing to the population's willingness to confront and adapt to changes in the international environment and related social, technological and economic challenges. Sweden's institutional, economic and financial conditions allow it to face the future with confidence. Much of the current Swedish debate is centred on the long-term sustainability of its achievements in a world economy transformed by the process of globalisation.

Over the last two decades, important parts of Swedish industry have become part of non-Swedish multinational enterprises (MNEs) with headquarters outside of Sweden. Large firms based in Sweden, which have long relied on international markets, have become truly "global" in reach and orientation. Irrespective of their ownership, these enterprises are guided by their global corporate strategies. Although Sweden has benefited from internationalisation, there are concerns that this will become harder as globalisation develops further, and there is a perception of a growing exposure to risk.

Co-operation between the state, large industrial firms and labour unions has been a pillar of Sweden's development. Public procurement, often involving long-term development partnerships, played an important part in the emergence of large, globally operating Swedish firms. Under the current international framework some of these practices have been made obsolete. Sweden has adapted well to the changes. It has nurtured and maintained a strong industrial base with an exceptionally broad range of products and economic activities. In addition Swedish manufacturers have successfully integrated sophisticated service components into their products (*e.g.* engineering, maintenance, network management), and market services have grown dynamically. Sweden's large and highly developed services sector accounts in fact for an increasingly large share of aggregate employment. Enhancing its efficiency will be necessary to maintain high

productivity growth and to ensure high-quality service delivery at affordable cost. Sweden's currently strong position should not, however, lead to complacency; the world is changing rapidly and further challenges lie ahead.

… requires new initiatives to tap new sources of growth

This report takes the view that an advanced country's long-run economic performance depends on sustained productivity growth, which in turns relies significantly on the level and quality of its innovation activities, *i.e.* the ability to generate, transfer and assimilate technological, non-technological, managerial, organisational and institutional innovations.

Sweden has one of the highest incomes per capita in the OECD area but has not been able to close the gap in GDP per capita *vis-à-vis* the United States because of lagging labour productivity. It therefore needs to innovate to foster multi-factor productivity (MFP) growth and achieve sustainable increases in labour productivity, per capita income and social welfare, as well as to remain internationally competitive in an increasingly globalised economy. Sweden is well aware that its prosperity hinges on a continued flow of innovation, both absorbed from abroad and developed at home. This requires strong investment in R&D and innovation but also, and vitally, a well-functioning innovation system that ensures high returns on these investments. Sound framework conditions for innovation include a stable economy, low inflation, a robust financial system, well-functioning product and labour markets, vigorous competition, including in key services sectors, international openness to international trade and foreign direct investment (FDI) and low barriers to entrepreneurship.

The OECD Innovation Strategy has argued that innovation policy can contribute significantly to innovation performance and an innovative, knowledge-based economy and society. Learning from best innovation policy practices in innovating countries plays an important role. Sweden is in many respects on the innovation frontier and should aim to extend this lead to innovation policy design and delivery.

Main strengths and weaknesses of the Swedish innovation system

Sweden's innovation performance is one of the best in the world. On many innovation indicators commonly used in international comparisons, it stands at the top or near the top, rivalled only by countries such as Switzerland, which shares some structural features with Sweden.

Table 0.1 presents the results of a SWOT analysis of the Swedish innovation system. Overall, Sweden is a leading innovation performer and needs to remain one in order to sustain its high standard of living and quality of life. It faces certain challenges but can build on its strengths and capabilities to tackle them.

Table 0.1. SWOT (strengths, weaknesses, opportunities, threats) analysis of Sweden's innovation system

Strengths	Opportunities
• Successful socioeconomic development combining economic success with a high degree of equality and outstanding quality of life. • Specialisation at the high end of global value chains and fast-developing innovative services. • Good framework conditions for innovation including solid macroeconomic fundamentals and institutions, a robust financial system and a supportive business environment. • A strong human resource base. • High investment in R&D and other knowledge-based capital and a strong ICT infrastructure. • A strong science base with high inputs, strong actors (notably research universities) and very good output in terms of the number and quality of scientific publications. • Excellence in industrial research and world-class innovation. Strong MNEs operating globally, including in R&D and innovation. • Participation in international academic and industrial networks, including in key areas such as pharmaceuticals, ICT and engineering. • Successful participation in European Framework Programmes and other international co-operative efforts. • High quality of institutions, which fosters transparency and high levels of trust, reduces transaction costs and facilitates adaptation to changing environments. • Wide public acceptance of innovation and recognition of the importance of science, technology and innovation (STI) for sustainable future growth.	• Good conditions to benefit further from globalisation. • Increased contribution of the strong core of academic research institutions to social and economic development. • Development of larger and more prominent centres of excellence at the top universities. • Development of regional knowledge hubs involving the new smaller universities (possibly with public research institutes). • Further internationalisation of research, including through attraction of foreign researchers and students and the attraction of FDI in R&D. • Development of a comprehensive innovation strategy to strengthen core actors and long-term commitments across sectors and levels of government. • Strengthening of smaller firms in various ways. • Further development of innovation in services. • Larger-scale policy initiatives to address Grand Challenges, including demand-side instruments. • New approaches and practices in innovation procurement adapted to the new environment.
Weaknesses	**Threats**
• Some aspects of the framework conditions for innovation, *e.g.* the area of financing. • Declining educational performance (PISA results). • A suboptimal system of academic IP. • University centres of competence/excellence are relatively small which can reduce their impact. • Insufficient links between traditional universities and SMEs. • Innovation policy is weak relative to other policy areas, *e.g.* higher education. • Lack of a holistic, "all-of-government" approach to innovation policy. • Large number of medium-sized funding agencies engaged in similar funding activities. • Unclear governance in regional innovation policies. • Uneven record on evaluation.	• Failure to maintain high productivity growth. • Loss of competitiveness, as new global actors enter the high end of value chains and markets. • Failure to maintain existing advantages (*e.g.* in clinical research). • Failure to make full use of the country's rich knowledge base and loss of innovative edge in the face of global competition. • Insufficiently structured technology transfer and links between industry and research. • Failure to nurture the emergence of new industrial activities, including in the services sector. • Increasingly fierce competition for top international talent in Swedish universities. • Offshoring of MNE production activities and leading corporate research centres (*e.g.* pharmaceuticals). • Overemphasis on consensus building when decisions need to be taken rapidly.

Scope for improving and further developing innovation policy

While Sweden has a strong innovation policy, its role is relatively weak when compared to higher education policy for example. There is scope for improvement in specific areas, and shortcomings need to be addressed to increase innovation's contribution to socioeconomic development. One of the most important tasks of innovation policy is to provide a conducive framework and incentives for co-operation between Sweden's strong universities and its relatively small public research institutes (PRIs) and industry. This review identifies a number of ways to improve practices in this area. Other tasks include the way innovation policy is governed and delivered. In Sweden this involves many fairly autonomous, medium-sized agencies operating a host of sometimes overlapping, medium-sized programmes.

Given its advanced economy and society and capable public administration, Sweden can be a pioneer in policy development, notably in the areas of public service innovation and innovative procurement.

Strategic tasks

The overriding task of Sweden's innovation policy is to help maintain and strengthen innovation as a driver of sustainable growth in order to maintain the high living standards and quality of life enjoyed by Sweden's population. It must meet the challenges presented by the transformation of the world economy that is currently under way. The rapid growth of emerging economies, notably in Asia, and the ensuing shift in the centre of economic gravity, offer new opportunities but also create challenges for high-income countries. Firms from emerging economies are developing the capabilities to compete even in knowledge-intensive market segments.

Sweden will need world-class innovation capabilities to sustain a steady flow of innovations and drive continuous increases in productivity in Swedish manufacturing and service firms and thus maintain its international competitiveness and strengthen its knowledge-based activities at the high end of global value chains. Achieving this goal implies:

- Providing Swedish business with world-class framework conditions and business environment as well as world-class infrastructure, including in ICT, one of Sweden's major assets.
- Increasing the economic and social benefits derived from R&D performed at Sweden's strong and well-endowed universities and comparatively small PRI sector. These can help anchor Swedish and foreign-owned enterprises in the Swedish innovation environment.
- Further fostering internationalisation in order to be at the forefront of science, technology and innovation and attract and retain the best students, researchers, enterprises and research centres.
- Adopting and pioneering new approaches to innovation and innovation policy, including in services.

Guiding principles

In formulating and implementing policies to carry out the strategic tasks described above, the Swedish government should adopt the following guiding principles:

- *Take a broad approach to innovation.* Innovation should encompass R&D-based and technological innovation but also innovation in organisations, marketing, business models, etc. Innovation policy should avoid a too narrow focus on "high technology". Non-technological or "soft" innovation – notably in SMEs, which need to build innovation capabilities but often face barriers – can facilitate firms' growth and offer opportunities for boosting productivity and income. Recent OECD work has found that investment and growth in OECD economies is increasingly driven by knowledge-based capital (KBC). In some OECD countries, firms now invest as much or more in KBC as in physical capital such as machinery, equipment and buildings. This shift reflects long-term economic and institutional transformations in OECD economies. Sweden has been at the forefront of these developments.
- *Highlight innovation in services.* An innovation policy that aims to stimulate economic growth should pay due attention to the services that play a growing role in economic activity. They account for some 70% of GDP in Sweden. Potential drivers of service innovation include: new technology, which can enable the development of new services; "servitisation" of the manufacturing sector (*i.e.* a blurring of the boundary between goods and services); deregulation and privatesation of the public sector (*e.g.* the energy, education and health area); services to meet societal challenges (*e.g.* eHealth services for elderly, energy-preserving services, ICT services to support sustainable cities). However, innovation policy is not yet sufficiently attentive to services to have an impact on economic growth.
- *Further strengthen international openness.* Sweden has a very open economy and innovation system. International knowledge flows are critical for the development of national innovation systems, even in the most advanced economies, as much of the knowledge needed to sustain innovation-driven growth will come from abroad. Circulation of foreign and national students and researchers in and out of the country, R&D-related inward and outward investment by international firms, and research performed domestically by foreign organisations are all important in this respect. The changing global landscape of R&D and innovation and open innovation models adopted by business firms worldwide create new opportunities and challenges. The channels mentioned above need to be complemented by access to knowledge through markets for technology, active participation in international innovation networks and research co-operation, as well as outward investment in R&D. This requires a genuinely open approach to internationalisation in all parts of the innovation system, including innovation policy.
- *Ensure quality, relevance and critical mass in public research.* This requires rigorous selection based on transparent criteria among research projects and teams applying for support. It also requires the active involvement of research end users in defining research priorities, adequate levels of funding and some concentration of resources in selected areas (priority setting). University competence centres can play an important role by focusing strategic research and innovation and helping to change the co-operation behaviour of partners involved.

- *Ensure effective governance.* Advanced innovation policy requires a systemic and strategic approach to innovation to reduce policy fragmentation and foster critical mass. Effective governance of STI policy includes co-ordination of the policies affecting innovation performance and co-ordination at the central, regional and municipal levels of government. The quality of governance in the major pillars of the innovation system, including universities (and the smaller PRIs), is critical. Rebalancing the policy mix requires adjustment, including towards a stronger service orientation.
- *Continue emphasising the adoption of good evaluation practices.* Regular external evaluation of publicly funded support programmes and institutions – preferably with international participation, a practice which Sweden has pioneered – should cover all parts of the innovation system. Evaluation should be firmly embedded in the policy cycle so that evaluation results feed back into subsequent rounds of support and policy design. Sweden is well placed to employ and develop the advanced methodologies and tools needed for a thorough impact assessment.

Recommendations

In light of these strategic tasks and guiding principles, and taking due account of Sweden's innovation-related strengths, weaknesses, opportunities and threats, a number of policy recommendations can be made.

Maintain supportive framework conditions for innovation and entrepreneurship

Conducive framework conditions are essential for a country's overall innovation performance. Framework conditions that affect innovation, in addition to basic requirements such as macroeconomic stability and openness to international trade and foreign direct investment, include competition, the regulatory regime, intellectual property rights and the tax system.

Macroeconomic stability

The aggregate level of effective demand and an economy's ability to boost it in recessions (through countercyclical budgetary policy) provide positive signals for firms considering investments in productivity-enhancing long-term projects (especially if they rely on external financing). The macroeconomic context in Sweden is relatively favourable. Following the recession of 2008-09, Sweden's economy grew faster than that of the OECD area as a whole in 2010 and 2011. Economic activity was hit again by the global economic slowdown in 2011 and growth is expected to remain modest in 2012, although higher than in many other European countries. In 2013, Sweden's growth is projected to gain momentum. Labour market participation has been higher in Sweden than in many other OECD economies during the crisis, yet unemployment remains quite high. Certain economic and institutional conditions may afford greater macroeconomic resilience than in many European counterparts:

- Relatively strong public finances which allowed the governing coalition to introduce stimulus measures during the crisis period, mainly focused on the labour market. In the event of a marked worsening of the international economic situation fiscal resources are adequate to inject additional stimulus.
- A comparatively robust banking sector.

- Competitive exports (even if the outlook for growth is currently weak owing to recessive conditions in many of Sweden's trading partners).
- Comparatively low price inflation.

The 2012 budget includes stimulus-oriented infrastructure investments in roads and railway maintenance, a package of active labour market measures, and steps to strengthen the welfare system.

Other framework conditions

In addition to the relatively conducive macroeconomic context, other framework conditions are largely supportive of innovation and entrepreneurship, such as low regulatory barriers, declining corporate tax rates and strong human capital.

Competitive markets are central to innovation, even if the circumstances under which competition has the most effect on innovation remain an issue. Sweden's product-market policy settings are largely in line with OECD best practice, although the extent of public control over economic activity is above OECD average levels.

Sweden has one of the highest levels of household access to broadband Internet among OECD members. Business access exceeds the OECD or EU averages but is somewhat behind the leaders.

In terms of high-growth firms in the services sector, Sweden is only surpassed by Israel and Estonia. It is relatively easy to establish a company in Sweden, and available data do not indicate significantly negative societal attitudes towards entrepreneurship. However, some entrepreneurs see a need for attention to this issue.

In recent years Sweden has lowered its corporate income tax; today, at 26.3%, the combined corporate income tax rate is in line with the OECD average. Nevertheless, capital gains from the sale of shares/securities are taxed at 30%, one of the higher rates in Europe, and aspects of the tax system affecting risk finance may need review. Work is under way on tax incentives for venture capital, an issue that will be addressed in the 2013 Budget Bill.

Access to bank lending is good, and for some time Sweden has had one of the largest venture capital sectors in the OECD area. However, the activity of private venture capital funds has contracted sharply in recent years in terms of volume and number of funds. Business angel activity appears relatively limited. The government has taken an active policy role in the financing of risk capital. However, certain operations of publicly supported organisations may need to be revised. Salient issues are the commercial logic behind the creation and operation of funds, the independence of evaluations, the balance between support for early- and later-stage investment, co-ordination of publicly supported organisations, and the complementary role of demand-side ("investment-readiness") initiatives. The government has stated its intention to restructure publicly owned venture capital institutions, and a proposal to co-ordinate venture capital initiatives will be included in the 2013 Budget Bill.

Recommendations

The government should:

- *Maintain sound macroeconomic conditions, including sustainable public finances, one of the most important prerequisites for dynamic private and public investment in innovation*.
- *As part of an ongoing effort to give due attention to their impact on innovation, the government should continuously screen key framework conditions to ensure their alignment with best practice*. Some of this will be done as a matter of course, and for reasons not directly related to innovation, but doing so is nevertheless critical for maintaining high levels of private and public investment in innovation.
- *Undertake a comprehensive examination of how the tax system affects equity finance for growth companies, including the scope for tax deductions for investment in growth companies and the taxation of stock options*.
- *Examine the legal framework for specialised business (association) forms to ensure that the absence of suitable legal structures does not create a barrier to early-stage equity finance*. It appears that there are currently no associational forms for individual, repeat business angels, or for joint business angel companies for organised venture investing. Also reported to be lacking is an efficient specialised limited partnership arrangement for small venture capital funds.
- *Ensure that the evaluation of publicly supported venture funds is fully independent.* Independent evaluation is essential as is impact assessment (rather than simple audits or monitoring).
- *In line with what is generally considered global best practice, examine where direct public support for equity finance could be provided through a fund-of-funds approach. More generally, examine where more commercially oriented approaches – with more co-financing from private investors – can be included in overall public support for venture finance*. A commercially oriented investment decision often leads to better outcomes in terms of development and employment. Public support might also focus to a greater degree on the early growth stage of equity finance, where there is less risk of crowding out private financing. A proposal for the co-ordination of initiatives to supply venture capital is reported to be included in the 2013 Budget Bill.
- *Examine the overall balance of supply- and demand-side measures for early-stage equity financing.* Improving the investment readiness of Swedish start-ups, and possibly improving entrepreneurs' knowledge of intellectual property (IP) issues, might be as beneficial, or more beneficial, than seeking to augment public funds for equity investment.

Maintain a world-class human resource base for science, technology and innovation

Educational attainment in Sweden is high and is one of the major assets of its innovation system. The share of different population age-groups with tertiary education surpasses the OECD averages. Human resources for science and technology (HRST) are well developed and women are well represented among tertiary-level students. Public provision of adult education at compulsory, secondary and tertiary levels is relatively generous. However, educational results in Swedish schools have been declining since the mid-1990s in all subjects. There is also evidence that the teaching profession has become less attractive as a vocation.

Some in the business sector hold the view that Swedish companies face a shortage of engineers. This claim, however, was disputed by others working in tertiary education and the evidence of whether such alleged shortages are real or important is limited. There is some international evidence that job-placement schemes for university graduates in scientific and engineering fields may help to lower barriers to careers in small firms. Other than joint PhD student placements funded by the Knowledge Foundation involving smaller universities and partner firms, there appears to be little experimentation with such schemes in Sweden. There were complaints from the private sector regarding the lack of support for taking on interns or students. Overall, the firms interviewed were supportive of partnership arrangements with higher education institutes on curricula or student hiring.

Entrepreneurship education has been promoted in recent years in a number of educational institutes and takes many forms. Internationally, various appraisals of entrepreneurship education in tertiary institutions have found that a high share of graduates go on to establish firms or to operate firms that grow rapidly. But many of these assessments fail to control for the fact that those most likely to become an entrepreneur are also those most likely to choose an entrepreneurship education programme. In evaluating such schemes, it should be borne in mind that providing students with realistic expectations regarding entrepreneurship can be useful, even if it discourages some would-be entrepreneurs.

More could be done to attract and retain top international talent and the potential role of foreign-born graduates and researchers in starting up business firms does not seem to have received the attention it deserves. The introduction of tuition fees for foreign (non-European Economic Area) students may be counterproductive from this perspective.

Recommendations

The government should:

- *Continue to pay attention to problematic developments in early stages of education.* It is recognised that the Swedish government has set out and begun implementation of a series of reforms which seek, among other things, to increase the attractiveness of a teaching career, improve school results, and raise the number of young people interested in mathematics, technology and science.
- *Monitor reported mismatches between supply and demand in the labour market for engineers and other skilled personnel required for innovation.*
- *Consider whether there are adequate employee placement schemes for graduates targeted at small and high-technology firms.* Private-sector support for business

partnerships with education institutes appears generally strong. Such partnerships can help align curricula and help avoid or bridge skills gaps. Given private-sector interest, an assessment of whether such partnerships are sufficiently developed might be undertaken.

- *In monitoring entrepreneurship education initiatives, seek to encourage programme assessments that take account of selection effects in student intake.*
- *Foster international academic openness through stronger inward internationalisation.* While Sweden's academic research is highly international in some respects (*e.g.* co-publications, international co-operation) it seems a little less so in others (*e.g.* active international recruitment). While Sweden compares well with "average" OECD countries, it does not have the internationalisation (and dynamism) of Switzerland. It would be worth studying the aggressive international recruitment strategies of some top European universities (and the internal structures they offer as host organisations) in order to strengthen Sweden's position in the international competition for talent.
- *Make better use of universities' role in hosting foreign students and researchers.* A number of countries offer good conditions and infrastructure to attract top foreign researchers and students. Foreign-born students and researchers play an outstanding role in the commercialisation of the research of leading centres of research and innovation, *e.g.* Chinese and Indians in Silicon Valley. It will be important to monitor the impact of tuition fees on the willingness of foreign students to study in Sweden.

Improve public governance of the innovation system

Sweden's public governance arrangements are modern and forward-looking, with high levels of participation. As in every country, these are shaped by historical developments that inevitably create legacies and lock-ins. Salient features of Swedish public governance include: small ministries and a multitude of strong agencies; strong decentralisation, with local governments accounting for almost half of public expenditures; a traditional but faded sectoral approach to technology policy involving public-private partnerships; and policy approaches that seek to achieve national consensus.

Co-ordination is a major concern of public governance efforts and has several aspects. From a vertical, principal-agent perspective, ministries direct their agencies through laws and regulations, an annual allocation of appropriations and tasks in the framework of multi-annual bills, and appointments to senior posts. Worth highlighting are the research and innovation policy bills prepared by the Ministry of Education and Research in consultation with other ministries, funding agencies, research performers and research users. These have been prepared every four years since 1982 and offer an important opportunity to take a strategic overview of the research and innovation system and to set out structural priorities for the coming years. Although it takes a rather research-oriented perspective on innovation that reflects the policy remit of the co-ordinating ministry, this mid-term framework is a positive element. It helps agencies with mid-term planning and strategies while providing a framework for the government to set priorities.

Nevertheless, Swedish agencies enjoy a significant degree of autonomy in terms of priority-setting and programme design and implementation, and the ministries, which are small and thin in terms of capabilities, are ill-equipped to be involved at this level. Monitoring and evaluation could help ministries have a stronger voice, but the agencies control

evaluations. While the evidence is mixed, agencies such as VINNOVA provide evaluations that are useful for the whole innovation system, but other agencies and funding councils have a mixed record on evaluating their work and its impacts. The evaluation culture in Sweden can be considered quite well developed, mainly for more qualitative studies and a broad array of impacts. However, few evaluations examine institutional change (*e.g.* in universities as a result of programmes) or evaluate the work and impact of whole funding agencies.

Horizontal co-ordination is also a major concern. It appears weak between the two main ministries, the Ministry of Enterprise, Energy and Communication and the Ministry of Education and Research. This may be due, in part, to their small size and limited resources. But the overall weak standing of innovation policy probably also contributes to weak horizontal co-ordination. For example, while nominally the remit of the Ministry of Enterprise, Energy and Communication, innovation is not explicitly mentioned as one of its nine main responsibilities on its website. Innovation is subsumed under research in the Ministry of Education and Research. The Ministry of Enterprise, Energy and Communication has attempted to develop a more strategic and whole-of-government approach to innovation policy. In 2004, a national innovation strategy was formulated, closely coinciding with the establishment of an Innovation Policy Council chaired by the Minister of Enterprise, Energy and Communication. Neither is considered to have been successful: implementation of the innovation strategy fell somewhat short of expectations and the Council ceased operations within a few years. To avoid a similar fate, it will be important for the 2012 innovation strategy to have strong follow-up action across government and among key stakeholders.

At another level, governance is closely related to the allocation of resources, and Sweden has a rather fragmented landscape of over 20 mostly mid-sized agencies funding innovation-related activities. This situation arose from the setting up of fully fledged research councils and technology funding agencies, a practice which began much earlier than in most comparable countries. A second reason for the fragmented landscape is the fact that a number of research councils and agencies operate under sector ministries. Third, a stream of supporting actors appeared with the transformation of the "wage earner funds" into foundations supporting science and innovation activities similar to those funded by government organisations. Finally, many private foundations have emerged over the years.

While this funding landscape provides a strong network, the fragmentation is not without consequences. First, although the goals and ambitions of the funding organisations are high, the individual budgets are not. Even VINNOVA is quite small in view of its mission and its ambition. This is particularly striking when compared to the budgets of organisations with similar missions in comparable countries (the budget of Finland's TEKES is around three times VINNOVA's). The many medium-sized actors undertake medium-sized interventions, both at the programme level and particularly at the level of the units funded.

In this organisational landscape, the only way to achieve sizeable results seems to be to do similar things in parallel. In contrast to the ministry level, co-ordination between funding agencies appears strong, as evidenced by high levels of joint-programming (for example, around half of VINNOVA's budget is allocated to programmes that are run jointly with other agencies). This leads to interesting constellations, as some programmes are co-ordinated and co-funded by up to six agencies. There also seems to be a great deal of cross-membership on agency boards and a significant amount of senior staff mobility between agencies, which contributes to much informal networking. The resulting

patchwork of funding may lend resilience to the system, as there is always a funding source for a good idea, but the limited size and large number of agencies limits their capacity to act as agents of change capable of pushing the Swedish system towards a more integrated and strategic innovation policy. Swedish innovation policy would profit from addressing a few large-scale challenges through large actors and instruments, thereby avoiding fragmentation and parallel action.

Recommendations

The government should:

- *Enhance the strategic direction of innovation policy across government*, for example through the implementation of the newly published Innovation Strategy. In doing so, the government should learn the lessons of the 2004 innovation strategy, the implementation of which largely failed to live up to expectations.
- *Improve inter-ministerial co-ordination of innovation policy* through closer inter-ministerial co-operation on the research and innovation bill and the national innovation strategy. Consideration should also be given to an integrated Research and Innovation Policy Council along the lines of the Finnish example. This recommendation needs as a prerequisite a *higher ranking of innovation on the policy agenda of the Ministry of Enterprise, Energy and Communication*.
- *Generate and utilise more strategic policy intelligence, e.g.* through evaluation and foresight studies that take a broader view of the innovation system. In this spirit, consideration should be given to commissioning a systems evaluation to analyse the roles, functions, rationales and records of the Swedish actors, including the main funding agencies, councils and foundations. Similar exercises have taken place in Norway, Austria and the Czech Republic.
- *Reduce the fragmentation of funding support*. Agency collaboration on programmes (joint programming) is a reaction to the fragmented funding landscape, which is itself difficult to reform. Nevertheless, serious consideration should be given to consolidating the fragmented landscape of funding agencies, not only from the perspective of transaction costs, and to creating a few powerful "innovation champions".
- *Introduce a few high-profile, large-scale initiatives, in addition to the many, often parallel medium-sized activities in policy making and funding.* This does not automatically conflict with Sweden's deeply rooted consensus principle, as past initiatives have demonstrated. For example:
  - *Use the innovation strategy and successive planning activities to formulate a small number of large initiatives to promote innovation.* Such an approach could be inspired by the European Grand Challenges.
  - *Create larger centres and contribute to the build-up of real critical mass in scientific as well as collaborative research.* Fewer and larger programmes generally tend to be more effective.
- *Consider doubling the budget of VINNOVA if current ambitions for this agency are maintained.* This review sees in VINNOVA the central innovation policy player in Sweden. However, there is a danger of ever smaller interventions under ever larger systems headlines with ever more parallelism with other actors.

Foster innovation in the business sector

Sweden has a strong export-oriented business sector with strong capabilities in R&D and innovation. For a country of its size it has nurtured an extraordinary array of large, highly internationalised firms operating in diverse medium- and high-technology manufacturing and services industries, comparable only to Switzerland's corporations. Nearly half (45%) of production is exported, and the top ten firms each had more than EUR 10 billion turnover in 2010. The public sector has played a pivotal role historically in nurturing such firms, often working in close co-operation with them in "development pairs". However, international competition rules, for example, on state aids, have reduced the scope for pursuing a "development pairs" strategy. Furthermore, globalisation has profoundly transformed the large enterprises that Sweden has nurtured. Foreign ownership has increased since the 1990s and activities and related resources are allocated within global corporate structures. This raises the risk that parts of production and research activities will move offshore; it also means Sweden must compete to retain and attract economic activities, including corporate R&D.

It is essential to anchor globally operating enterprises in Sweden within dense research and innovation networks. Sweden's strong business services sector, knowledge infrastructure, and research institutes (particularly universities) can play an even greater role in this regard. Different universities and public research institutes (PRIs) can assume different roles. Yet, the recent closure of a large corporate pharmaceutical research lab raises the question of how to anchor capacities successfully in fast-changing sectors. At the same time, there is a lack of prominent examples of R&D-motivated (re)location of foreign research or production units to Sweden. Such inward relocations have occurred in countries such as Switzerland and the United States owing to the quality of university research and to more liberal regulatory frameworks.

In the longer term a stronger innovative SME sector would make Sweden less dependent on a relatively small number of large firms and could enable the growth of new ones. This requires framework conditions (see above) that are commensurate with global best practice. An improved knowledge base in Sweden's population of innovative SMEs would also be beneficial.

R&D investments by industry are concentrated in large firms. Indeed more than 80% of business enterprise expenditure on R&D (BERD) is performed by large firms. At 2.5% of GDP (around EUR 8 billion) Sweden's BERD as a proportion of GDP is one of the highest in the OECD area. Three-quarters are accounted for by industry and one quarter by services. Sectors with high volumes of R&D spending (2009) include: machinery and electro/electronics industries (EUR 2.7 billion); the automotive industry (EUR 1.6 billion); and pharmaceuticals (EUR 600 million).

At the same time, analysts and policy makers increasingly recognise that innovation entails more than R&D. While research on innovation has traditionally focused on universities, laboratories, scientists and R&D workers, recent literature has highlighted the importance of knowledge-based capital (or intangible) assets used in production and owned by business, such as computerised information (software and databases), innovative property (patents, copyrights, designs, trademarks) and economic competencies (including brand equity, firm-specific human capital, networks joining people and institutes, and organisational know-how that increases enterprise efficiency). New measurement and analytical efforts have drawn attention to the large and growing scale of business investments in intangibles, and have identified such investments as a key source of changes in productivity and GDP. Recent data suggest that Sweden is one of the

OECD economies in which business investment in these assets is highest as a share of GDP and may have accounted for almost 30% of labour productivity growth in Swedish manufacturing during 2000–06. Investment in intangibles is affected by many policy areas, including a broad array of framework conditions.

Like other high-performing OECD countries, such as Germany and Switzerland in Europe and Japan and Korea in Asia, which have nurtured large R&D-performing business enterprises, Sweden does not use subsidies for R&D extensively (as measured by the share of government funding of business R&D). The Swedish funding portfolio has a rather small number of programmes targeting individual firms. At the same time, it is one of the few OECD countries, along with Germany and Finland, that do not offer fiscal incentives for business R&D (such as a tax credit scheme). This is understandable given the industry structure (*i.e.* very large corporate actors) and the fact that large Swedish firms are subject to a corporate taxation scheme that appears to favour re-investment of profits. While both direct and fiscal support often operate in parallel, the introduction of a fiscal incentive scheme involves trade-offs. It may unduly complicate the tax system, carry deadweight losses, and raise problems of controlling appropriate use. Costs for the taxpayer can be high. While Sweden's discipline concerning subsidies is commendable, it might consider some increase in support for SMEs while trying to meet their needs in the most effective way. If this would involve support for small firms through fiscal measures, it should also cover firms that are not currently profitable.

EU funding provides additional financial support for firms. The strong participation of Swedish actors in the Framework Programmes (FP) has led to a strong inflow of funds and much success. Well-organised industry sectors such as telecommunications or car manufacturing have successfully used the FPs for precompetitive or standardisation work. Large firms continue to participate in FPs in this way. While the level of participation of SMEs is below the EU average, it is comparable to other leading small economies. Nevertheless, higher levels of SME participation are desirable.

Support for firms' innovation activities could also be achieved through large-scale projects and consortia around Grand Challenges, which can provide platforms and focusing devices for strategic innovation. Sweden has already set ambitious targets regarding decarbonisation, renewable energies and sustainability. Strong co-development arrangements with ensuing market opportunities for participating firms could emerge from such an approach.

Recommendations

The government should:

- *Provide a world-class innovation environment in order to attract and retain innovative firms.* As mentioned, this requires excellent framework conditions but also more targeted initiatives. Local initiatives can make important contributions (*e.g.* through local ICT infrastructure, cluster-oriented initiatives, etc.).
- *Use all available means to anchor large firms and their activities in production and research in a world-class Swedish innovation environment*. This includes sharpening the profiles of strong universities, *e.g.* through larger centres of excellence (see below).
- *Make the growth of innovative SMEs a main focus of a revamped and strengthened innovation policy.* Both young and established SMEs should be kept in policy focus. A degree of public support for these enterprises' R&D and innovation efforts is necessary to correct widespread market failures in the SME sector. Care should be taken to nurture high-growth firms.
- *Consider raising the amount and level of direct innovation funding to SMEs, e.g.* by enlarging programmes such as those as provided by VINNOVA and the Knowledge Foundation to support the placement of academically trained people in SMEs. Such initiatives can help small firms enter more sophisticated product and process development cycles and link them to universities through transfers of people.
- *If new fiscal incentives for R&D are considered, they should be targeted at SMEs, including those not currently profitable*. It is necessary to evaluate critically whether such a scheme should be offered in the Swedish system.
- *Extend attention from traditional R&D-based innovation to non-R&D-based innovation in firms, including innovation in services and creative industries*. Make a special effort to meet the needs of these enterprises which are sometimes difficult to reach.
- *Foster design competencies*, one form of intangible asset, through particular attention to education and training policies that seek to balance supply and demand in the market for design skills as well as to the system of design rights so that these are easily understood and their registration and enforcement straight-forward and inexpensive.

Balance the policy mix: The role of demand-side policies

Like other countries, Sweden has a rich array of supply-side policy support measures that address a mix of market and system failures, *e.g.* in knowledge production, in innovation financing, in building linkages, etc. On the demand side, public procurement has played a significant role in the history of a number of Sweden's largest and most innovative companies. However, contemporary legal frameworks, including state aid rules, now preclude many practices that were previously employed. Recent years have seen a revival of attempts to use public procurement to stimulate innovation. Sweden is no exception and indeed it is argued that the country has a comparative advantage in following this route. To date, however, initiatives to promote new-generation, innovation-oriented procurement have largely involved preparatory work, and a few other countries

have made more progress than Sweden. This preparatory work has identified a range of institutional structures and practices that could be amended or improved to foster pro-innovation procurement. Part of the challenge now is to act on these findings in a concerted and systematic manner. In so doing, it is important to ensure some degree of standardisation and structured learning in sub-national governments.

Aside from public procurement of innovation, a number of countries operate programmes to purchase R&D services from SMEs, and Sweden's Forska&Väx supports R&D in SMEs. However, no programme currently appears to seek to integrate SMEs into the R&D procurement process systematically in the way that the United States' SBIR does (a VINNOVA report prepared in 2009 argued that Forska&Väx was too small and too limited in scope). Sweden might benefit from a full-blown SBIR-type scheme.

Recommendations:

- *Enrich the traditional set of instruments with demand-side instruments* such as innovation-driven procurement, *e.g.* in "green" technology areas.
- *Consolidate the lessons and recommendations stemming from the many inquiries and pilot activities pertaining to pro-innovation procurement and proceed to implementation*. It is important to monitor closely and evaluate the effectiveness and efficiency of innovation procurement, as and when it is introduced at significant scale.
- *Examine ways to ensure standardisation and structured learning in pro-innovation procurement across sub-national governments*.
- *Ensure that comprehensive information and guidance are available for procurement bodies, including at regional level*. More broadly, attention should be paid to clarifying the circumstances under which innovation procurement at sub-national level is likely to be viable. Not only are some specific skills and forms of know-how typically less present at sub-national level, but the scale economies necessary to the success of some types of pro-innovation procurement may be lacking.
- *Consider whether the introduction of a full-blown SBIR-type initiative would add significantly to the existing suite of innovation support instruments available (i.e.* whether by filling a gap in the current service offering such an initiative would be likely to increase the overall level of innovation in SMEs at reasonable cost).

Foster critical mass, excellence and relevance in public-sector research

Most publicly funded research in Sweden is carried out in higher education institutes (HEIs) and is concentrated in a few universities. HERD, at 0.9% of GDP in 2010, leads the OECD. Nearly 60% of total HERD funding goes to five universities. In comparison, the public research institute (PRI) sector is relatively small, accounting for approximately 3% of GERD. The scientific productivity of Swedish researchers, as measured by publication counts in leading journals, is high by international standards, as is scientific quality as measured by citation rates, although Switzerland performs considerably better.

Higher education institutes

Sweden has a number of world-class research universities with internationally known and well-networked research groups. Four HEIs, Karolinska, Lund, Stockholm and Uppsala, regularly feature among the top 100 or so HEIs in global rankings (such as the *Times Higher Education Supplement* and Shanghai rankings). In recent decades a number of new universities/university colleges have been added to the Swedish HEI system. Several have established themselves well as niche players, both geographically and in terms of specialisation. These new universities also display interesting collaboration patterns with regional industry, both smaller firms and multinational affiliates.

In the Swedish support structure, funding of academic research is of great importance. Direct state funding to HEIs has been the fastest-growing revenue stream in recent years and corresponded to 47% of total revenues for research (including support for doctoral students) in 2010. Much of HEIs' remaining funding comes from the government or from other public sources in the form of project funding. The research funding agency, the Swedish Research Council (*Vetenskapsrådets – VR*), is well endowed and there are a number of other actors for specific fields (*e.g.* FORMAS for sustainability, FAS for work-related research, STEM for energy, or Riksbankens RJ for the social sciences and humanities) or for more specific kinds of activities. A specialised funding organisation, the Knowledge Foundation, provides support to university colleges for collaboration with industry on their research and teaching activities. The proportion of HERD funded by industry declined over the last decade to 4.5% in 2009, about two-thirds of the OECD (6.3%) and EU27 (6.4%) averages.

A much utilised funding instrument is the "centre programme". Broadly speaking, there are two types: "excellence" centres that reflect scientific excellence and "competence" centres for more applied and collaborative research with industry. The centres are legally part of the host universities. Typical Swedish centres of either type seldom have an annual budget of over EUR 1 million, which is quite small by international comparison. As a result, a fleet of similar mid-sized centres is found at each of the top universities. They provide for very good working conditions and exposure but they may lack the critical mass to drive these universities' innovation agendas.

Given its strengths in industrial and scientific research, Sweden has, in principle, excellent opportunities for strong and beneficial industry-academic linkages. In the past, an industrial policy strategy centred on "development pairs" saw strong collaboration between major Swedish firms and the public sector, which, to some extent, included HEIs and PRIs. Today, inspired by an innovation system logic, several funding agencies operate programmes to encourage industry-academic links. For example, VINNOVA has a raft of schemes for science-industry collaboration, technology transfer and related initiatives on entrepreneurship and inter-firm co-operation, while the Knowledge Foundation supports research conducted at Sweden's new universities, provided that industry actively participates and provides matching funds. Many of these programmes directly address academic or other public research actors that submit applications and receive funding, while industrial involvement often comes in the form of in-kind and/or cash contributions.

At the same time, the so-called "professor's privilege" means that HEIs have relatively weak infrastructures for commercialising their R&D and weak patenting performance. While a system of exclusive inventors' rights has some advantages with regard to potential spin-off creation or shortcutting bureaucratic deadweight and infrastructure costs, it also has downsides. For instance, HEIs have little knowledge of the

IP generated with their resources and cannot build up an organisational IP portfolio from which to derive a revenue stream. The main caveat with all kinds of university IP holding and management arrangements is that they must be undertaken in an extremely professional way, with top specialists and a long-term view. International experience suggests shortfalls are common, in which case it is probably better not to have such arrangements.

A set of newly established innovation offices are intended to promote more knowledge transfer from HEIs, by supporting researchers who wish to commercialise their research results and even to establish spin-off companies. While it is too early to assess their performance, their scope suggests that they fall short of being the full-fledged technology transfer offices found in many HEIs around the world. There is certainly considerable scope for better exploiting knowledge transfer mechanisms in HEIs. But such efforts should acknowledge that the benefits of HEI research lie predominantly in the advanced skills it generates, which are very attractive to high-technology firms, assuming, of course, substantial inter-sectoral mobility and contact. Many of the benefits of academic research are embodied in students and researchers, which points to the importance of close co-operation with business and social actors both in research and training, as well as the need for conditions that promote mobility.

HEIs can also access EU Framework Programme money as another source of funding in an already generous system. Two recent European funding lines are of particular note: Sweden was highly successful in the first round of Knowledge and Innovation Communities (KICs) with the European Institute of Technology (EIT) and has performed quite well in applications to the European Research Council (ERC).

Recommendations

The government should:

- *Help make universities stronger and more proactive players in the innovation system.* The work on university profiling and the strengthening of organisational leadership should be continued. At the same time, HEIs should be more strongly encouraged to foster the build-up of critical mass internally. It is important to foster differentiation within and between HEIs and allow for greater specialisation and the build-up of centres of excellence. Larger and better structured centres can also improve the interface with industry (including SMEs) and the public. Universities should be encouraged to be more outward-looking and entrepreneurial, to raise the number and share of industry contracts, to nurture strong centres of excellence, and to employ an active IP strategy.
- *Continue to increase R&D support to university colleges while maintaining their distinctiveness* vis-à-vis *the leading research HEIs*. At the same time, grouping some university colleges into single entities with critical mass and possibly including some RISE (Research Institutes of Sweden) institutes in these efforts should be considered. This will be important for managing the impacts of demographic change, which threatens the existence of some smaller institutes.

- *Reward research excellence.* Sweden is moving slowly towards research assessment in support of block grant allocations. With their increased autonomy, HEIs should also be subject to stronger accountability regimes through research assessment.
- *Improve the attraction and retention of top researchers from abroad, particularly in universities*. Take note of the Swiss ETH sector (ETH Zurich and EPF Lausanne) for excellence-based academic recruiting.
- *Revisit the "professor's privilege" arrangements.* If a system of university-held IP is being introduced, it should follow the best models in the world. At the same time, conduct an early review of the innovation offices established by HEIs.
- *Retain the existing policy focus on collaborative partnerships while drawing lessons from experience to improve some of the instruments*. In particular, a strong focus on better linking SMEs to knowledge producers should be a priority.
- *Strengthen links between HEIs and the business sector on teaching and curriculum design*, for example, by extending the VINNPRO scheme to establish graduate schools with strong business participation.

Public research institutes

There are two main kinds of public research institute (PRI) in Sweden. One is the research institutes that are more or less government agencies but have permission to charge for services performed, such as the Swedish Defence Research Agency (FOI) and VTI, which focuses on transport analysis and construction of transport systems. These agencies' main customers are the Defence and Transport ministries, respectively, and are not covered extensively in the review. The second kind addresses industrial research and has as its main mission the provision of R&D services for the Swedish business sector. In principle, private-sector businesses buy R&D services from these institutes and the state funds an ordinance covering their facilities and skills development. The research institutes' work is largely demand-driven and is intended as an interface between academic research and product development in the business sector.

The research institutes that focus on industrial research have been grouped in recent years under an umbrella holding, RISE, to improve strategic orientation, pool resources and exploit complementarities. There are four main substructures under the small RISE holding, all with a number of individual institutes clustered around topics such as ICT. The institutes mostly have different business approaches, depending on the sectors served. The models range from testing contracts to real research consortia. Taken together, the institutes employ more than 2 100 people, more than a third with PhDs.

Government support for research institutes has been increasing in recent years. One specific mechanism includes VINNOVA's Institute Excellence Programme, another centre programme which is specific to the RISE institutes. A number of successful institutes work in "triangles" involving universities, RISE and the enterprise sector. The development of links between universities and RISE is therefore seen as an opportunity, with some universities taking a positive view of such collaborations. The European Institute of Technology's Knowledge and Innovation Communities (KICs) appear to be a valuable example in the field of ICT and build on long-standing collaboration by Ericsson, the RISE institutes and KTH Royal Institute of Technology. Cluster approaches and second-tier MNE research groups are interesting partners. RISE also benefits from

government policy initiatives at the regional level, where RISE institutes have successfully participated in VINNVÄXT consortia.

Recommendations

The government should:

- *Keep the RISE structure stable and let it grow moderately if it directly serves the needs of SMEs/SME-dominated sectors*.
- *Screen possibilities of mergers between institutes and (smaller) universities if such a move could lead to strong regional actors with a clear thematic focus*.

Strengthen regional innovation policy and its alignment with national policy

Sweden places considerable emphasis on spatial equity and balanced regional development and has managed to develop more remote, less favoured regions over several decades. Some of these regions profit from a strong traditional industrial base in sectors like mining/metallurgy and wood/pulp and paper. Others have specialised in smaller niches like car components or specific services. Nevertheless, regional disparities are strong and the booming regions in the southern part of the country continue to absorb talents and opportunities.

Regional innovation policies have gained importance in most OECD countries over the last two decades. Starting with informal co-ordination bodies and cluster initiatives, Swedish regional innovation policy approaches have become more formalised and increasingly important in the wider innovation policy agenda. Greater territorial equity is still an important policy goal, but the policy instrument mix of distributive and infrastructural policies has been complemented by policies that aim to nurture endogenous regional innovation capabilities. EU Structural Funds and territorial activities in EU innovation policies have further catalysed this shift. While in former periods EU regional funding was characterised by the support of physical infrastructures and an overall focus on poorer or remote regions, the ongoing 2007-2013 period puts stronger emphasis on innovation and formally includes the whole country.

EU Structural Funds are administered by the Swedish Agency for Economic and Regional Growth (*Tillväxtverket*), including management of applications, funding decisions and monitoring. A recent review of measures supporting innovation and entrepreneurship concludes that many are too broad and insufficiently adapted to conditions and audiences that vary considerably by region; colleges and universities are among the main beneficiaries but this has tended to compromise the Fund's innovation outcomes in favour of research; and functional evaluation and a culture of learning are weak.

Tillväxtverket is also the largest national funder of regional innovation schemes, many of which are directed at supporting innovative entrepreneurship. Many other national agencies also have targeted innovation programmes at the regional level, notably the Knowledge Foundation and VINNOVA. This fragmentation allows experimentation but creates co-ordination problems. These problems are further exacerbated by the variable states of development of the regions themselves. For the most part, regions are weakly developed, since policy mandates and resources reside at the national and municipality levels. In the late 1990s, Skåne and Västra Götaland obtained "pilot region" status, where directly elected regional authorities took over responsibilities for regional development from state agencies. This encouraged a stronger bottom-up policy approach that led to mobilisation of additional regional actors and to formulation of regional development and innovation strategies. Further regional policy steps in the mid-2000s

were less ambitious and led to the formation of (weaker) regional coordination bodies in other regions. This spectrum of devolution means that national policy actors are confronted with a variety of different actors with different mandates in different regions.

Recommendations

The government should:

- *Explore ways to better adapt European and national initiatives to regional specificities*. This will require strengthened innovation policy competencies at the regional level.
- *Encourage a broad set of actors beyond universities and colleges to take leading roles in regional innovation programmes*. This would likely strengthen innovation outcomes.
- *Nurture a learning culture around innovation policy interventions at the regional level*. Evaluations should be more than procedural and offer opportunities for mutual learning between the different regional actors. There should also be ample opportunities for international learning around regional innovation policy.

Strengthen public sector innovation and social innovation

Innovation agendas have traditionally focused on S&T developments that benefit business innovation, particularly product innovation in manufacturing firms. It is recognised today that this focus is too narrow for a national innovation agenda. In particular, it misses the dynamics and potential benefits of innovation in the public sector and society more widely.

The public sector is among the largest service providers in many OECD countries, and service delivery accounts for a large part of government expenditures. The pressure on the public sector to innovate and change is mounting as many "public tasks" (such as administration) are increasing in volume and/or complexity, while the available resources are not.

Knowledge of how countries have implemented innovative approaches in the public sector is still fragmented and a common definition of what innovation means for public-sector organisations is lacking. More needs to be done to understand the boundary between public-sector reform and innovation. Sweden has played an active part in trying to develop the knowledge base, *e.g.* through joint Nordic efforts to improve the measurement of public-sector innovation. Furthermore, the government recently established the National Council for Innovation and Quality in the Public Sector to improve the efficiency and quality of public activities at national, regional and local levels. The Council aims to support and stimulate innovation and change in public services through analysis and proposals of measures to promote innovation and development in the public sector. It is due to report in mid-2013.

In the realm of social innovation, Sweden has an international reputation for being socially responsible and environmentally conscious. In 2008, the Knowledge Foundation started to fund research and training programmes in this area and has since sponsored the set-up and operation of the Forum for Social Innovation Sweden. The Forum gathers together academic, business, public and non-profit stakeholders who want to promote social innovation. In 2012, it will present an outline of a strategy for working with social innovation and social entrepreneurship in the future.

Recommendations

The government should:

- *Broaden the framework of innovation policy to ensure that it covers public sector and social innovation.* Swedish innovation policy continues to place considerable emphasis on support for R&D and innovation in manufacturing firms, but this view needs to be broadened to cover all aspects of innovation.
- *Continue to support a better conceptual and empirical basis for measuring and promoting public-sector innovation*.
- *Develop and implement experiments in the public sector to nurture innovation*.
- *Ensure that know-how regarding public-sector innovation reaches the regional and municipal levels. Likewise, ensure that lessons from experiments at regional and municipal levels are widely shared, possibly through new or existing knowledge-sharing forums*.
- *Develop business models for sustainable social innovation, taking note of international practices in the area*.

Maximise benefits from the internationalisation of R&D and innovation

National systems of innovation can remain successful only if they are closely linked to and embedded in international knowledge networks. This is especially so for small economies like Sweden, where access to new knowledge, technologies and know-how generated and developed outside of national borders plays a crucial role in successful innovation. The need for an international perspective is further driven by the need to compete with other countries to attract and retain knowledge-intensive investments in an increasingly globalised world. Finally, addressing the so-called "Grand Challenges", whose scale and scope extend well beyond national borders, necessitates participation in international agenda-setting and coordinated actions.

Sweden is already extremely well linked internationally, through trade relations, foreign direct investment and cross-border R&D collaboration. A strong export orientation and the activities of highly internationalised large enterprises have been key factors in Sweden's economic development, and Swedish firms are well established in today's global value chains. Whether judged by international trade and investment flows or the extensive presence of Swedish businesses abroad and foreign companies in Sweden, Sweden ranks among the top ten countries in most comparative assessments.

Mergers and acquisitions, particularly over the last two decades, have seen many Swedish firms become affiliates of large MNEs headquartered outside of Sweden. Today, around a third of Sweden's business R&D is performed by foreign-owned firms or foreign affiliates. At the same time, large Swedish-owned firms continue to expand their overseas operations, particularly in production, but also in R&D. The 20 largest "Swedish" corporations, irrespective of their ownership, invest nearly as much in R&D abroad as they do in Sweden. The corporate strategies of internationalised firms are shaped by a variety of factors, only a few of which can be influenced by government policy. Besides the broad framework conditions for innovation, these include the availability of high-level skills and state-of-the-art research infrastructure and the presence of strong networks of firms, public-sector research performers, educational establishments, and government policy makers.

In common with many OECD countries, the main "failure" of internationalisation in the business sector lies with SMEs, which often lack the resources to enter overseas markets on their own. The Swedish Trade Council is especially active in supporting and promoting trade of SMEs. VINNOVA views improved internationalisation of its various cluster programmes as a possible conduit for high-technology SMEs to enter overseas markets, though this would seem to be rather limited. At the same time, Invest Sweden has done some exploratory work with science parks on improving opportunities for strategic alliances with and investments from overseas firms.

International R&D collaboration is extensive and has been accelerated by strong participation in the EU's Framework Programmes. Today, around 55% of Sweden's leading academic publications are co-authored with overseas researchers, a high proportion in international comparison.

Unlike Germany, for example, Sweden has yet to develop an overarching internationalisation strategy in the area of research and innovation, although the idea of doing so has been discussed for some time. Its advocates judge it necessary to provide a more strategic and co-ordinated approach to international co-operation and linkages, to achieve consistency and synergy between national and international research and innovation promotion activities, and to ensure that public policy interventions add value to the extensive international collaboration that already exists between individuals, organisations and businesses. Among these are a long and fruitful history of Nordic co-operation, strong participation in the EU's Framework Programmes, bilateral agreements with leading and emerging scientific powers, *e.g.* the United States and China, and the research programme of the Swedish International Development Cooperation Agency (SIDA).

Recommendations

The government should:

- *Consider developing an explicit internationalisation strategy for R&D and innovation*. While such a strategy should explicitly set out orientations and actions to promote internationalisation, these should be integral to and mainstreamed in existing policies and programmes. Such a strategy, while providing some "top-down" strategic orientation, should also respect the important "bottom-up" activities that will need to continue to support a thriving innovation system.
- *Consider developing an explicit national strategy targeted at EU research and innovation*. This could be part of a wider internationalisation strategy but would require special attention given the growing weight and influence of EU funding in the Swedish innovation landscape.
- *Actively explore various avenues to intensify the internationalisation of SMEs*. This is a multi-faceted problem with a variety of possible solutions involving a range of agencies. An overarching strategy could be useful for fostering collaborations involving a mix of solutions.
- *Continue strengthening links to established and emerging global centres of innovation*. The rise of Asian and other fast-developing economies requires a broader focus on internationalisation while not forgetting the continuing importance of maintaining strong links to Europe and North America.

Notes

1 Lennart Schön paraphrasing the economist Moses Abramovitz, in "Technological Waves and Economic Growth – Sweden in an International Perspective", Circle, Lund University Paper No. 2009/06), on which this section partly draws.

2 Sweden joined the European Union in 1995 together with Austria and neighbouring Finland but decided to remain outside the European Monetary Union.

Examen de l'OCDE de la politique d'innovation de la Suède : Évaluation globale et recommandations

Les caractéristiques historiques, culturelles, institutionnelles et géographiques de la Suède sont des considérations importantes si l'on veut évaluer l'état actuel de son système d'innovation. Avec ses neuf millions d'habitants, ce pays a connu historiquement un développement économique et social exceptionnel. La Suède, qui a commencé à s'industrialiser au milieu du 19e siècle alors qu'elle n'était qu'un pays relativement pauvre dont l'économie reposait sur les ressources naturelles, est maintenant une société avancée avec un État protecteur généralement appelé « modèle suédois ». À divers égards, la Suède est aujourd'hui un des pays les plus innovateurs dans le monde. Elle a surmonté les contraintes d'un petit marché intérieur grâce à un fort degré d'internationalisation, notamment par l'émergence des grandes entreprises suédoises. Le développement de la Suède s'appuie depuis longtemps sur l'innovation, même avant que cela ne soit explicitement considéré comme un facteur essentiel de la croissance économique et du développement social. Comme on le verra ici, l'innovation est aussi la clé de l'avenir de la Suède dans un monde globalisé.

Réalisations et défis : Poursuivre une trajectoire de développement socioéconomique historiquement remarquable

La Suède a commencé à s'industrialiser au 19e siècle et est devenue graduellement une solide nation technologique. Toutefois, son développement n'a pas été linéaire : le système d'innovation suédois est devenu ce qu'il est aujourd'hui par des vagues de développement successives, chacune caractérisée par des facteurs de croissance particuliers.

Une trajectoire de développement économique et social particulièrement réussie

L'histoire du développement de la Suède sur plus d'un siècle est impressionnante. Comme l'ont noté les historiens de l'économie, entre 1850 et 1970, la Suède a d'abord rattrapé les pays précocement industrialisés comme la Grande-Bretagne, puis a commencé à « aller de l'avant ».[1] À partir du milieu du 19e siècle, l'économie et la société suédoises ont été transformées par l'introduction de procédés sidérurgiques innovants, la création d'usines modernes et la construction de chemins de fer. Cela s'est accompagné d'une croissance des exportations (principalement de produits agricoles et sylvicoles et de fer) et des importations de machines et équipements ainsi que de savoir-faire technologique, notamment de Grande-Bretagne.

La Suède fut alors en mesure de participer pleinement à la deuxième révolution industrielle des machines et de l'ingénierie, de la chimie et des biens de consommation. Une génération d'entreprises à forte intensité de savoir, parmi lesquelles AGA, Asea (ABB), Ericsson, Separator (Alfa Laval) et SKF, est apparue entre 1880 and 1910. Comme dans d'autres pays à l'époque, ces entreprises étaient souvent créées par des inventeurs-entrepreneurs ayant une formation de scientifique ou d'ingénieur. L'abondance d'énergie hydraulique a joué un rôle crucial dans le développement de la Suède. À partir de 1930 environ, des « blocs de développement » se sont constitués autour des équipements électriques (ménagers), de l'automobile et des services (Volvo, Saab, Electrolux ou encore Tetra Pak, IKEA ou H&M). Le « bloc de développement » de l'électronique et des TIC est monté en puissance à partir d'environ 1970.

Les marchés publics ont été un facteur majeur de l'innovation et du développement économique durant une partie importante de l'histoire moderne de la Suède. On le constate à l'évidence dans les « couples de développement » associant des entreprises et des partenaires publics ou privés, certains engagés dans des relations de très longue durée comme ASEA-Vattenfall pour le transport de l'électricité, les commutateurs numériques AXE et la norme GSM (Ericsson-Televerket), etc. Le cadre d'interaction et de coopération entre le gouvernement et les partenaires sociaux et le partage des gains de productivité, ainsi que le haut niveau d'éducation et de qualifications, ont été des appuis essentiels.

Toutefois, après trois décennies de prospérité après-guerre, la croissance tendancielle de l'économie suédoise a fini par ralentir et la croissance de la productivité s'est essoufflée. Au début de la décennie 90, la Suède a subi une sévère récession et le « modèle suédois » a connu des tensions croissantes. L'entrée de la Suède dans l'Union européenne,[2] a entraîné des changements institutionnels dans des domaines comme la libéralisation des marchés de produits et de capitaux, la formation des salaires et les règles de marchés publics. L'investissement a commencé à se déplacer des biens physiques vers les biens incorporels (comme la R-D). Divers ajustements et réformes ont contribué à redresser les performances économiques de la Suède dans les années 90 et la croissance du PIB et de la productivité s'est accélérée. La Suède a ensuite continué sur une trajectoire favorable durant la plus grande partie de la première décennie du 21e siècle. Comme d'autres économies ouvertes dans le monde, la Suède a été touchée par une contraction de la demande extérieure durant la crise financière et économique de 2008-09. Cependant, la Suède a montré un haut degré de résilience, a mieux supporté la crise que d'autres pays et a rebondi rapidement. Après la récession, la croissance de l'économie suédoise a été sensiblement supérieure à celle de la zone OCDE dans son ensemble. Pourtant, la Suède n'est pas à l'écart des événements que connaissent l'Europe et l'environnement économique mondial en général.

Réussir dans un monde globalisé…

Dans l'ensemble, le « modèle suédois » s'est montré remarquablement résilient, la population consentant à faire front et à s'adapter aux changements de l'environnement international et aux défis sociaux, technologiques et économiques qu'ils soulèvent. La situation institutionnelle, économique et financière de la Suède lui permet d'aborder l'avenir avec confiance. Une grande partie du débat actuellement en cours en Suède porte sur la durabilité à long terme de ses réalisations dans une économie mondiale transformée par le processus de la globalisation.

Au cours des deux dernières décennies, des composantes importantes de l'industrie suédoise ont été intégrées à des entreprises multinationales non suédoises ayant leur siège en dehors du pays. Les grandes entreprises suédoises, qui s'appuient depuis longtemps sur les marchés internationaux, sont devenues véritablement « globales » dans leur portée et leur orientation. Quels que soient leurs propriétaires, ces grandes sociétés obéissent à des stratégies mondiales. Bien que la Suède ait tiré bénéfice de l'internationalisation, on craint que cela ne devienne plus difficile avec la poursuite de la globalisation et il existe un sentiment d'exposition croissante au risque.

La coopération entre l'État, les grandes entreprises industrielles et les syndicats a été un des piliers du développement de la Suède. Les marchés publics, comportant souvent des partenariats de développement de longue durée, ont joué un rôle important dans l'émergence de grandes entreprises suédoises opérant à l'échelle mondiale. Dans les conditions internationales actuelles, certaines de ces pratiques sont devenues obsolètes. La Suède s'est bien adaptée aux changements. Elle a construit et préservé une forte base industrielle, avec un éventail de produits et d'activités économiques exceptionnellement large. En outre, les entreprises manufacturières suédoises ont réussi à intégrer à leurs produits des composantes de services élaborées (ingénierie, maintenance, gestion de réseau) et les services marchands ont enregistré une solide croissance. Le secteur des services suédois, de grande taille et hautement développé, représente en fait une part de plus en plus importante de l'emploi total. Il sera nécessaire d'en renforcer l'efficience pour maintenir une forte croissance de la productivité et pour assurer la livraison de services de haute qualité à un coût abordable. La Suède ne doit pas se reposer sur ses lauriers malgré sa forte position actuelle ; le monde change rapidement et de nouveaux défis se profilent.

… nécessite de nouvelles initiatives pour exploiter de nouvelles sources de croissance

Le présent rapport considère que les performances économiques à long terme d'un pays avancé dépendent d'une croissance soutenue de la productivité, qui elle-même repose dans une grande mesure sur l'ampleur et la qualité de ses activités d'innovation, c'est-à-dire de sa capacité à créer, transférer et assimiler des innovations technologiques, non technologiques, managériales, organisationnelles ou institutionnelles.

La Suède a un des revenus par habitant les plus élevés des pays de l'OCDE mais elle n'a pas réussi à combler l'écart du PIB par habitant par rapport aux États-Unis à cause de sa moindre productivité du travail. Il lui faut donc innover pour stimuler la croissance de sa productivité globale des facteurs (PGF) et augmenter durablement la productivité du travail, le revenu par habitant et le bien-être social, ainsi que pour rester internationalement compétitive dans une économie de plus en plus mondialisée. La Suède a parfaitement conscience que sa prospérité dépend d'un flux continu d'innovation, aussi bien absorbée de l'étranger que créée dans le pays. Cela requiert un fort investissement dans la R-D et l'innovation mais aussi, de manière critique, un système d'innovation efficace assurant de hauts retours sur ces investissements. Le cadre propice à l'innovation consiste notamment en une économie stable, une faible inflation, un système financier robuste, un bon fonctionnement des marchés de produits et du marché du travail, une concurrence vigoureuse notamment dans les secteurs clés des services, l'ouverture aux échanges internationaux et à l'investissement direct étranger et de faibles barrières à l'entrepreneuriat.

Tableau 0.1. Analyse AFOM (atouts-faiblesses-opportunités-menaces) du système d'innovation suédois

Atouts	Opportunités
• Réussite du développement socioéconomique combinant le succès économique avec un haut degré d'égalité et à une qualité de vie exceptionnelle. • Spécialisation dans le haut des chaînes de valeur mondiales et développement rapide de services innovants. • Cadre propice à l'innovation avec des fondements et institutions macroéconomiques solides, un système financier robuste et un environnement propice à l'entreprise. • Forte base de ressources humaines. • Investissement élevé dans la R-D et autres actifs intellectuels et forte infrastructure de TIC. • Forte base scientifique avec des moyens importants, des acteurs puissants (notamment les universités de recherche) et une très bonne production du point de vue du nombre et de la qualité des publications scientifiques. • Excellence de la recherche industrielle et innovation de niveau mondial. Multinationales puissantes opérant à l'échelle mondiale, y compris dans la R-D et l'innovation. • Participation aux réseaux universitaires et industriels internationaux, notamment dans des domaines clés comme les produits pharmaceutiques, les TIC et l'ingénierie. • Participation réussie aux Programmes cadres européens et autres efforts de coopération internationaux. • Approches de long terme et de prévisibilité à l'égard de la politique de la recherche fondées sur le consensus et une réalisation pragmatique. • Des institutions de haute qualité qui encouragent la transparence et un niveau élevé de confiance réduit les coûts de transaction et facilite l'adaptation à des environnements changeants. • Large acceptation par la public de l'innovation et reconnaissance de l'importance de la science, de la technologie et de l'innovation (STI) pour une croissance future durable.	• Bonnes conditions pour continuer de tirer bénéfice de la mondialisation. • Contribution accrue du noyau dur des institutions de recherche universitaires au développement social et économique. • Développement de centres d'excellence de plus grande taille et plus en vue dans les universités de pointe. • Développement de pôles de savoir régionaux avec la participation des nouvelles petites universités (et éventuellement des instituts de recherche publics). • Poursuivre l'internationalisation de la recherche, notamment en attirant des chercheurs et étudiants étrangers et en attirant des IDE en R-D. • Développement d'une stratégie globale de l'innovation pour renforcer les acteurs clés et les engagements de longue durée entre les secteurs et les différents niveaux d'administration publique. • Renforcer de diverses manières les petites entreprises. • Poursuivre le développement de l'innovation dans les services. • Initiatives publiques à plus grande échelle pour s'attaquer aux « Grands défis », avec des instruments portant sur la demande. • Approches et pratiques nouvelles dans les marchés publics d'innovation adaptées au nouvel environnement.
Faiblesses	**Menaces**
• Certains aspects de l'environnement de l'innovation, comme le domaine du financement. • Baisse des performances éducatives (résultats PISA). • Système non optimal de gestion de la propriété intellectuelle universitaire. • Taille relativement petite des centres universitaires de compétences/ d'excellence, ce qui peut limiter leur impact. • Liens insuffisants entre les universités traditionnelles et les PME. • Politique de l'innovation faible par rapport à d'autres domaines d'action, comme l'enseignement supérieur. • Absence d'approche globale, « pangouvernementale », à l'égard de la politique de l'innovation. • Multiplicité des agences de financement de taille moyenne menant des activités similaires. • Manque de clarté de la gouvernance dans les politiques de l'innovation régionales. • Inégalité des efforts d'évaluation.	• Ne pas réussir à maintenir une forte croissance de la productivité. • Perte de compétitivité avec l'entrée de nouveaux acteurs mondiaux dans le haut des chaînes de valeur et des marchés. • Ne pas réussir à maintenir les avantages existants (par exemple, dans la recherche clinique). • Ne pas réussir à exploiter pleinement la riche base de savoir du pays et perdre l'avance d'innovation face à la concurrence mondiale. • Structuration insuffisante du transfert de technologie et des liens entre l'industrie et la recherche. • Ne pas réussir à alimenter l'émergence de nouvelles branches d'activité, y compris dans le secteur des services. • Concurrence de plus en plus intense pour le recrutement de personnel du plus haut niveau international dans les universités suédoises. • Délocalisation des activités de production des multinationales et de leurs grands centres de recherche (par exemple, dans l'industrie pharmaceutique). • Recherche excessive d'un consensus quand il faut prendre des décisions rapidement.

La Stratégie de l'OCDE pour l'innovation repose sur l'idée que la politique gouvernementale peut notablement contribuer aux performances en matière d'innovation et favoriser une économie et une société du savoir innovantes. L'inspiration apportée par les pratiques modèles observées dans les pays innovants est un élément important pour les pouvoirs publics. La Suède est à de nombreux égards à l'avant-garde de l'innovation et devrait s'efforcer d'étendre cette avance à la conception et à l'application de la politique de l'innovation.

Principaux points forts et points faibles du système d'innovation suédois

Les performances de la Suède en matière d'innovation sont parmi les plus élevées dans le monde. Pour beaucoup d'indicateurs de l'innovation couramment utilisés dans les comparaisons internationales, elle se situe au premier ou dans les premiers rangs, avec pour seuls rivaux des pays comme la Suisse, qui a avec la Suède certaines caractéristiques structurelles communes.

Le tableau 0.1 montre les résultats d'une analyse AFOM du système d'innovation suédois. Globalement, la Suède présente des performances de pointe en matière d'innovation et elle doit continuer à le faire pour pouvoir préserver son haut niveau de vie et sa qualité de vie. Elle doit faire face à certains défis mais elle peut compter sur ses points forts et ses capacités pour les relever.

Perspectives d'amélioration et de poursuite du développement de la politique de l'innovation

La Suède a une solide politique de l'innovation mais dont le rôle est relativement faible par comparaison avec la politique de l'enseignement supérieur, par exemple. Il existe une marge d'amélioration dans des domaines particuliers et certains défauts sont à corriger afin d'accroître la contribution de l'innovation au développement socio-économique. Une des tâches les plus importantes de la politique de l'innovation est d'établir un cadre propice et des incitations à la coopération entre les grandes universités suédoises (et les instituts de recherche publics, plus petits) et l'industrie. Le présent examen met en lumière quelques moyens d'améliorer les pratiques dans ce domaine. D'autres tâches visent la façon dont la politique de l'innovation est gouvernée et appliquée. En Suède, cela fait intervenir un grand nombre d'agences de taille moyenne assez autonomes, qui administrent une foule de programmes de moyenne ampleur qui se chevauchent quelquefois.

Étant donné son économie et sa société avancées et la capacité de son administration publique, la Suède peut être à l'avant-garde de l'élaboration des politiques, notamment dans le domaine de l'innovation des services publics et des marchés publics d'innovation.

Tâches stratégiques

La politique de l'innovation en Suède doit en premier lieu contribuer à maintenir et renforcer l'innovation comme moteur d'une croissance durable visant à préserver le haut niveau de vie et la qualité de vie dont bénéficie la population suédoise. Elle doit relever les défis dus à la transformation de l'économie mondiale actuellement en cours. La croissance rapide des économies émergentes, notamment en Asie, et le déplacement du centre de gravité économique qui en résulte, offrent des possibilités nouvelles mais soulèvent aussi des défis pour les pays à haut revenu. Les entreprises des économies émergentes développent leurs capacités de rivaliser même dans les segments de marché à forte intensité de savoir.

La Suède aura besoin de capacités de tout premier plan pour maintenir un flux continu d'innovations et accroître en permanence la productivité des entreprises du secteur manufacturier et des services dans ce pays, et ainsi préserver sa compétitivité internationale et renforcer ses activités reposant sur le savoir dans les maillons supérieurs des chaînes de valeur mondiales. Cela implique :

- D'assurer aux entreprises suédoises un cadre général et un environnement d'activité optimaux à l'échelon mondial ainsi qu'une infrastructure de premier rang, notamment dans les TIC, qui sont un des atouts majeurs de la Suède.
- D'accroître les avantages économiques et sociaux découlant de la R-D réalisée dans les universités suédoises puissantes et bien dotées et dans le secteur des instituts de recherche publics de moindre taille, qui peuvent contribuer à ancrer les entreprises suédoises ou étrangères dans l'environnement d'innovation suédois.
- De continuer à favoriser l'internationalisation pour être à l'avant-garde de la science, de la technologie et de l'innovation et pour attirer et retenir les meilleurs étudiants, chercheurs, entreprises et centres de recherche.
- D'adopter ou de lancer de nouvelles approches à l'égard de l'innovation et de la politique de l'innovation, notamment dans les services.

Principes directeurs

Dans la formulation et la mise en œuvre des mesures visant à accomplir les tâches stratégiques décrites ci-dessus, le gouvernement suédois devrait adopter les principes directeurs suivants :

- *Avoir une approche large à l'égard de l'innovation.* Celle-ci doit couvrir l'innovation à base de R-D et l'innovation technologique mais aussi l'innovation dans les organisations, le marketing, les modèles d'entreprise, etc. La politique de l'innovation ne doit pas se focaliser trop étroitement sur la « haute technologie ». L'innovation « douce », non technologique – notamment dans les PME, qui ont besoin d'acquérir des capacités d'innovation mais rencontrent souvent des obstacles – peut faciliter la croissance des entreprises et offrir des possibilités d'accroître la productivité et le revenu. D'après des travaux récents de l'OCDE, l'investissement et la croissance dans les économies de l'OCDE reposent de plus en plus sur les actifs intellectuels. Dans certains pays de l'OCDE, les entreprises investissent maintenant au moins autant dans les actifs intellectuels que dans le capital physique comme les machines, équipements ou

bâtiments. Cette évolution reflète les transformations économiques et institutionnelles des économies de l'OCDE sur une longue période. La Suède est à l'avant-garde de cette tendance.

- *Mettre l'accent sur l'innovation dans les services.* Une politique de l'innovation qui vise à stimuler la croissance économique doit porter l'attention qu'il convient aux services, qui jouent un rôle croissant dans l'activité économique et représentent en Suède environ 70 % du PIB. Les facteurs potentiels de l'innovation dans les services sont notamment : les technologies nouvelles, qui peuvent permettre la création de nouveaux services ; la « servicisation » du secteur manufacturier (brouillage de la distinction entre les biens et les services) ; dé-réglementation et privatisation du secteur public (par exemple, dans l'énergie, l'éducation ou la santé) ; services répondant à des défis sociétaux (par exemple, services de télésanté pour les personnes âgées, services d'économie d'énergie, services de TIC à la base des « villes durables »). Cependant, l'attention portée aux services par la politique de l'innovation n'est pas encore suffisante pour avoir un impact sur la croissance économique.
- *Poursuivre l'ouverture internationale*. La Suède a une économie et un système d'innovation très ouverts. Les flux de connaissances internationaux sont essentiels au développement des systèmes d'innovation nationaux, même dans les économies les plus avancées, étant donné qu'une grande partie du savoir nécessaire pour maintenir une croissance nourrie par l'innovation viendra de l'étranger. La circulation bidirectionnelle des étudiants et des chercheurs étrangers ou nationaux entre un pays et l'étranger, l'investissement entrant ou sortant réalisé par les entreprises internationales en rapport avec la R-D, et la recherche effectuée dans le pays par des organisations étrangères sont à cet égard des éléments de première importance. L'évolution du paysage mondial de la R-D et de l'innovation et les modèles d'innovation ouverte adoptés par des entreprises à travers le monde créent de nouvelles possibilités et de nouveaux défis. Les canaux mentionnés ci-dessus doivent aussi être complétés par l'accès aux connaissances à travers les marchés de technologie, par une participation active aux réseaux d'innovation internationaux et la coopération dans la recherche, ainsi que l'investissement en R-D sortant. Cela nécessite une approche de l'internationalisation véritablement ouverte dans toutes les parties du système d'innovation, y compris la politique de l'innovation.
- *Assurer la qualité, la pertinence et une masse critique dans la recherche publique.* Cela nécessite une sélection rigoureuse fondée sur des critères transparents parmi les projets et les équipes de recherche qui demandent un soutien. Cela nécessite aussi une participation active des utilisateurs finals de la recherche à la définition des priorités de la recherche, des niveaux de financement adéquats et une certaine concentration des ressources dans des domaines particuliers (priorisation). Les centres de compétence universitaires peuvent jouer un rôle important en focalisant la recherche stratégique et l'innovation et en contribuant à changer le comportement des partenaires concernés en matière de coopération.
- *Assurer une gouvernance efficace*. Une politique de l'innovation avancée doit appliquer une approche systémique et stratégique à l'égard de l'innovation afin de réduire la fragmentation des politiques et de favoriser une masse critique. La gouvernance de la politique de STI, pour être efficace, implique de coordonner

les différentes politiques qui influent sur les performances en matière d'innovation et nécessite aussi une coordination des administrations publiques de niveau central, régional et municipal. La qualité de la gouvernance dans les composantes majeures du système d'innovation, y compris les universités (et les instituts de recherche publics, de moindre taille), est essentielle. Il faut réajuster l'équilibrer des mesures, notamment avec une plus forte orientation vers les services.

- *Continuer de promouvoir l'adoption de bonnes pratiques d'évaluation.* L'évaluation externe des programmes d'aide et institutions financés par des fonds publics, réalisée à intervalles réguliers – de préférence avec une participation internationale, pratique dont la Suède a été une pionnière – doit couvrir toutes les parties du système d'innovation. L'évaluation doit être solidement intégrée au cycle des politiques de telle sorte que les résultats d'évaluation alimentent les étapes suivantes d'action de soutien et de conception des mesures gouvernementales. La Suède est bien placée pour utiliser et développer les outils et méthodologies avancés requis pour une évaluation d'impact approfondie.

Recommandations

À la lumière de ces tâches stratégiques et de ces principes directeurs, et compte tenu des « atouts, faiblesses, opportunités et menaces » de la Suède dans le domaine de l'innovation, on peut formuler un certain nombre de recommandations pour l'action gouvernementale.

Maintenir un cadre propice à l'innovation et à l'entrepreneuriat

L'existence d'un cadre propice est essentielle pour les performances globales d'un pays en matière d'innovation. Les conditions générales qui influent sur l'innovation, outre les exigences de base comme la stabilité macroéconomique et l'ouverture aux échanges internationaux et à l'investissement direct étranger, sont la concurrence, le régime réglementaire, les droits de propriété intellectuelle et le système fiscal.

Stabilité macroéconomique

Le niveau global de la demande effective et la capacité qu'a une économie de la stimuler en période de récession (par une politique budgétaire contracyclique) fournissent des signaux positifs aux entreprises qui envisagent des investissements dans des projets à long terme propres à accroître la productivité (particulièrement si elles recourent à un financement externe). Le contexte macroéconomique en Suède est relativement bon. Après la récession de 2008-09, l'économie de la Suède a enregistré en 2010 et en 2011 une croissance plus forte que celle de la zone OCDE dans son ensemble. L'activité économique a été touchée à nouveau par le ralentissement économique mondial de 2011 et on s'attend à ce que la croissance reste modeste en 2012, tout en étant supérieure à celle de beaucoup d'autres pays d'Europe. On prévoit une accélération de la croissance en Suède en 2013. La participation au marché du travail a été plus forte en Suède que dans beaucoup d'autres économies de l'OCDE durant la crise, mais le chômage reste élevé. Certaines caractéristiques économiques et institutionnelles lui apportent peut-être une plus grande résilience macroéconomique que dans beaucoup d'autres pays d'Europe :

- Des finances publiques relativement solides qui ont permis à la coalition au pouvoir de prendre des mesures de relance pendant la période de crise, principalement axées sur le marché du travail. Dans le cas d'une détérioration marquée de la situation économique internationale, les ressources budgétaires sont suffisantes pour une impulsion supplémentaire.
- Un secteur bancaire relativement robuste.
- Des exportations compétitives (même si, actuellement, les perspectives de croissance sont faibles en raison de la situation de récession chez beaucoup de partenaires commerciaux de la Suède).
- Une hausse des prix relativement faible.

Le budget 2012 contient une relance sous la forme d'investissements d'infrastructure dans les routes et l'entretien des chemins de fer, un ensemble de mesures actives du marché du travail et des actions visant à renforcer le système de protection sociale.

Autres conditions générales

En plus d'un contexte macroéconomique relativement favorable, d'autres éléments, comme de faibles barrières réglementaires, la baisse des taux d'imposition des sociétés et un fort capital humain, apportent un soutien notable à l'innovation et à l'entrepreneuriat.

La concurrence sur les marchés est essentielle à l'innovation, même si les circonstances dans lesquelles cette concurrence a le plus d'effet sur l'innovation restent une question ouverte. Les politiques appliquées en Suède aux marchés de produits concordent de manière générale avec les meilleures pratiques en vigueur dans l'OCDE, bien que l'étendue du contrôle public sur l'activité économique soit supérieure aux niveaux moyens de cette zone.

Le niveau d'accès des ménages suédois à l'Internet haut débit est un des plus élevés parmi les membres de l'OCDE. Pour les entreprises, le niveau d'accès est supérieur à la moyenne de l'OCDE ou de l'UE mais un peu en retrait des pays de tête.

En ce qui concerne les entreprises à forte croissance dans le secteur des services, la Suède n'est dépassée que par Israël et les États-Unis. Il est relativement facile de créer une société en Suède, et les données dont on dispose n'indiquent pas une attitude sociétale significativement négative à l'égard de l'entrepreneuriat. Toutefois, certains entrepreneurs pensent qu'il faut porter attention à cette question.

Ces dernières années, la Suède a abaissé l'impôt sur les bénéfices des sociétés ; aujourd'hui, à 26.3 %, le taux global de cet impôt se situe dans la moyenne de l'OCDE. Néanmoins, les plus-values réalisées sur les valeurs mobilières sont imposées à 30 %, un des taux les plus élevés d'Europe, et certains aspects de la fiscalité du capital-risque devraient peut-être être revus. Des travaux sont en cours sur les incitations fiscales en faveur du capital-risque, question qui figurera dans le projet de loi de finances 2013.

L'accès au crédit bancaire est bon et, pendant une certaine période, le secteur du capital-risque en Suède a été un des plus importants de la zone OCDE. Cependant, l'activité des fonds de capital-risque privés s'est fortement contractée ces dernières années, en volume et en nombre de fonds. L'activité des « bons génies » paraît relativement limitée. Les pouvoirs publics ont endossé un rôle actif dans le financement du capital-risque. Toutefois, certains aspects de l'action des organisations à financement public devraient peut-être être réexaminés. Les questions à revoir sont notamment la

logique commerciale de la création et du fonctionnement des fonds, l'indépendance des évaluations, l'équilibre entre le soutien à l'investissement à un stade précoce ou plus tardif, la coordination des organisations à financement public, et le rôle complémentaire des initiatives axées sur la demande (« préparation à l'accueil de l'investissement »). Le gouvernement a déclaré son intention de restructurer les institutions de capital-risque publiques et une proposition visant à coordonner les initiatives en matière de capital-risque sera incluse dans le projet de loi de finances 2013.

Recommandations

Le gouvernement devrait :

- *Maintenir de saines conditions macroéconomiques, notamment des finances publiques viables, ce qui est un des préalables les plus importants pour un investissement privé et public dynamique dans l'innovation.*
- *Dans le cadre d'un effort constant pour surveiller leur impact sur l'innovation, le gouvernement devraient examiner de manière continue les conditions clés du contexte pour assurer leur concordance avec les pratiques modèles.* Cela se fera pour une part naturellement et pour des raisons non directement liées à l'innovation, mais il est essentiel de maintenir de hauts niveaux d'investissement privé et public dans l'innovation.
- *Examiner de manière approfondie l'effet de la fiscalité sur le financement en fonds propres des entreprises de croissance, notamment les possibilités de déductions fiscales pour l'investissement dans les entreprises de croissance et l'imposition des options sur titres.*
- *Examiner le cadre légal des formes d'entreprise (formes sociales) spécialisées pour éviter que l'absence de structures juridiques appropriées ne fasse obstacle au financement précoce en fonds propres.* On constate qu'actuellement il n'existe pas de formes sociales pour les « bons génies » effectuant individuellement des investissements répétés ou pour des sociétés de « bons génies » afin d'investir en capital-risque de manière organisée. On signale aussi qu'il n'y a pas de forme spécialisée de société en commandite bien adaptée aux petits fonds de capital-risque.
- *Faire en sorte que l'évaluation des fonds de capital-risque à financement public soit totalement indépendante.* L'évaluation indépendante est essentielle, de même que l'appréciation d'impact (de préférence à de simples audits ou suivis).
- *À la lumière de ce qui est généralement considéré comme les meilleures pratiques mondiales, examiner dans quels cas un soutien public direct au financement en fonds propres pourrait être apporté par une approche de fonds de fonds. Plus généralement, examiner dans quels cas des approches à orientation plus commerciale – avec un plus fort cofinancement par des investisseurs privés – peuvent être incluses dans le soutien public global au capital-risque.* Une décision d'investissement d'inspiration commerciale conduit souvent à de meilleurs résultats en termes de développement et d'emploi. Le soutien public pourrait aussi se concentrer davantage sur le financement en fonds propres en début de croissance, où il y a moins de risque d'évincer le financement privé. On rapporte qu'une proposition visant à coordonner les initiatives pour l'apport de capital-risque doit être incluse dans le projet de loi de finances 2013.

- *Examiner l'équilibre global des mesures axées respectivement sur l'offre et sur la demande pour le financement précoce en fonds propres.* Améliorer la préparation aux investisseurs dans les jeunes pousses suédoises, et éventuellement améliorer la connaissance des questions de propriété intellectuelle chez les entrepreneurs, pourrait être aussi bénéfique, voire plus, que d'essayer d'augmenter les fonds publics destinés à l'investissement en fonds propres.

Maintenir une base de ressources humaines de niveau mondial pour la science, la technologie et l'innovation

Le niveau d'instruction est élevé en Suède et c'est un des atouts majeurs de son système d'innovation. La part des diplômés de l'enseignement tertiaire dans les différentes tranches d'âge de la population dépasse les moyennes de l'OCDE. Les ressources humaines en science et technologie (RHST) sont bien développées et les femmes sont bien représentées parmi les étudiants au niveau tertiaire. L'offre publique d'éducation des adultes au niveau de l'enseignement obligatoire, secondaire ou tertiaire est relativement généreuse. Toutefois, les résultats éducatifs dans les écoles suédoises sont en baisse depuis le milieu de la décennie 90 dans toutes les matières. On observe aussi que la profession d'enseignant attire moins les vocations.

Certains acteurs du secteur des entreprises pensent que les entreprises suédoises souffrent d'une pénurie d'ingénieurs. Cette affirmation est toutefois contestée par des membres de l'enseignement tertiaire et il y a peu de preuves que ces supposés manques soient réels ou importants. Certaines données internationales semblent indiquer que les dispositifs de placement en entreprise des diplômés en sciences et techniques des universités peuvent aider à réduire les obstacles aux carrières dans les petites entreprises. En dehors des placements de doctorants financés par la Knowledge Foundation entre de petites universités et des entreprises partenaires, il semble qu'il y ait peu d'expérimentation de ce type de dispositifs en Suède. Des plaintes ont été émises dans le secteur privé concernant le manque de soutien pour la prise en charge de chercheurs ou d'étudiants. Globalement, les entreprises interrogées étaient favorables aux partenariats avec les établissements d'enseignement supérieur concernant les programmes d'études ou l'embauche d'étudiants.

L'éducation à l'entrepreneuriat est en faveur depuis quelques années dans un certain nombre d'établissements éducatifs, et cela sous de nombreuses formes. Au niveau international, il ressort de diverses évaluations de l'éducation à l'entrepreneuriat dans les établissements tertiaires qu'une forte proportion de diplômés créent ensuite des entreprises ou dirigent des entreprises à forte croissance. Toutefois, beaucoup de ces évaluations ne prennent pas en compte le fait que les étudiants les plus susceptibles de devenir des entrepreneurs sont aussi les plus enclins à s'inscrire à un programme d'éducation à l'entrepreneuriat. Dans l'évaluation de ces programmes, il faut garder à l'esprit qu'il peut être bon de donner aux étudiants des espoirs réalistes concernant l'entrepreneuriat, même si cela peut décourager quelques vocations.

Il est possible de faire plus pour attirer et retenir les plus talentueux au niveau international et le rôle potentiel des diplômés et des chercheurs d'origine étrangère dans la création des entreprises ne semble pas avoir reçu l'attention qu'il mérite. L'introduction de droits de scolarité pour les étudiants étrangers (non originaires de l'Espace économique européen) peut être préjudiciable à cet égard.

Recommandations

Le gouvernement devrait :

- *Continuer de porter attention aux problèmes qui se posent dans les premiers stades de l'éducation.* Il est vrai toutefois que le gouvernement suédois a établi et commencé à mettre en œuvre une série de réformes visant, entre autres, à augmenter l'attrait de la carrière d'enseignant, à améliorer les résultats scolaires et à faire en sorte qu'il y ait plus de jeunes qui s'intéressent aux mathématiques, à la technologie et à la science.
- *Surveiller les écarts signalés entre l'offre et la demande sur le marché du travail concernant les ingénieurs et autres personnels qualifiés nécessaires à l'innovation.*
- *Examiner s'il existe des dispositifs suffisants pour l'emploi des diplômés visant les petites entreprises de haute technologie.* Le secteur privé semble en général très favorable aux partenariats avec les établissements éducatifs. Ces partenariats peuvent contribuer à adapter les programmes d'études et à prévenir ou combler les déficits de compétences. Eu égard à l'intérêt exprimé par le secteur privé, il pourrait être utile d'examiner si ces partenariats sont suffisamment développés.
- *Dans le suivi des initiatives d'éducation à l'entrepreneuriat, promouvoir les évaluations de programme qui prennent en compte les effets de sélection dans l'inscription des étudiants.*
- *Favoriser l'ouverture universitaire sur les autres pays en renforçant l'internationalisation du recrutement.* Si la recherche universitaire suédoise est très internationale à certains égards (copublications, coopération internationale), elle le semble un peu moins sur d'autres plans (par exemple, un recrutement international actif). La Suède se situe à un bon niveau par comparaison avec les pays « moyens » de l'OCDE, mais elle n'a pas l'internationalisation (et le dynamisme) de la Suisse. Il serait utile d'étudier les stratégies de recrutement international énergiques de certaines grandes universités européennes (et les structures internes d'accueil qu'elles offrent) afin de renforcer la position de la Suède dans la concurrence internationale pour attirer les plus talentueux.
- *Mieux utiliser la fonction d'accueil des étudiants et chercheurs étrangers remplie par les universités.* Un certain nombre de pays offrent des conditions favorables et une bonne infrastructure pour attirer les meilleurs chercheurs et étudiants étrangers. Les chercheurs et étudiants d'origine étrangère jouent un rôle de premier plan dans la commercialisation des travaux des centres de recherche et d'innovation de pointe, par exemple les Chinois et les Indiens dans la Silicon Valley. Il sera important de surveiller l'impact des droits de scolarité sur la propension des étrangers à étudier en Suède.

Améliorer la gouvernance publique du système d'innovation

La Suède s'est dotée de dispositifs de gouvernance publique modernes et tournés vers l'avenir, avec un niveau élevé de participation. Comme dans n'importe quel pays, ces dispositifs ont été façonnés par l'Histoire, avec pour conséquences inévitables des aspects hérités du passé et des blocages. La gouvernance publique en Suède présente les caractéristiques suivantes : des ministères et une multitude d'organismes publics influents ; une forte décentralisation, les autorités locales représentant pratiquement la

moitié des dépenses publiques ; une approche sectorielle traditionnelle mais vieillie de la politique technologique avec des partenariats public-privé ; et des politiques visant le consensus au niveau national.

La coordination est une préoccupation majeure pour la gouvernance publique, et elle se présente sous plusieurs aspects. Du point de vue de la relation verticale entre mandant et mandataire, les ministères dirigent les organismes placés sous leur dépendance au moyen de lois et de règlements, d'une répartition annuelle des dotations et des tâches dans le cadre de projets de loi pluriannuels, et de nominations aux postes de direction. Il faut souligner les projets de loi en matière de recherche et d'innovation préparés par le ministère de l'Éducation et de la Recherche en consultation avec les autres ministères ainsi que les organismes de financement, les centres de recherche et les utilisateurs. Ces projets de loi sont préparés tous les quatre ans depuis 1982 et constituent une importante opportunité d'obtenir un panorama stratégique du système de recherche et d'innovation et de définir les priorités structurelles pour les années à venir. Bien qu'il adopte une perspective sur l'innovation tournée vers la recherche, qui reflète les attributions politiques du ministère assurant la coordination de l'ensemble, ce cadre à moyen terme est un élément positif. Il sert de référence aux organismes pour leur planification et leurs stratégies à moyen terme tout en fournissant aux pouvoirs publics un cadre pour la détermination des priorités.

Néanmoins, les organismes publics suédois jouissent d'un degré important d'autonomie en termes de définition des priorités et de conception et réalisation des programmes, et les ministères, dont les capacités sont réduites, sont mal outillés pour pouvoir intervenir à ce niveau. Des activités de contrôle et d'évaluation pourraient permettre aux ministères d'avoir davantage d'influence, mais ce sont les autres organismes qui contrôlent les évaluations. Si les données ne vont pas toutes dans le même sens, des agences comme VINNOVA fournissent des évaluations qui sont utiles à l'ensemble du système d'innovation, mais les autres organismes et les organes de financement présentent un bilan mitigé dans le domaine de l'évaluation de leur activité et de ses impacts. La culture de l'évaluation, en Suède, peut être considérée comme bien développée, surtout pour les études plutôt qualitatives et pour un vaste ensemble d'impacts. Cependant, moins nombreuses sont les évaluations portant sur les changements institutionnels (p.ex. dans les universités, par suite de la réalisation des programmes) ou sur l'activité et l'impact des organismes de financement.

La coordination horizontale est aussi une préoccupation essentielle. Elle apparaît faible entre les deux principaux ministères, le ministère de l'Entreprise, de l'Énergie et de la Communication et le ministère de l'Éducation et de la Recherche. Cela peut s'expliquer en partie par leur petite taille et par leurs ressources limitées. Il est cependant probable que cette faible coordination horizontale soit aussi imputable au poids globalement faible de la politique d'innovation. Ainsi, par exemple, bien qu'elle relève normalement de la compétence du ministère de l'Entreprise, de l'Énergie et de la Communication, l'innovation n'est pas mentionnée explicitement sur son site internet comme étant une de ses neuf grandes responsabilités. L'innovation est englobée dans les activités de recherche du ministère de l'Éducation et de la Recherche. Le ministère de l'Entreprise, de l'Énergie et de la Communication s'est efforcé de développer une approche plus stratégique et pangouvernementale de la politique d'innovation. En 2004, une stratégie nationale d'innovation a été définie, qui coïncidait étroitement avec la création d'un Conseil de la politique de l'innovation présidé par le ministre de l'Entreprise, de l'Énergie et de la Communication. Aucun de ces deux dispositifs n'est

considéré comme une réussite : la mise en œuvre de la stratégie d'innovation a quelque peu déçu les attentes, et le Conseil a cessé son activité au bout de quelques années. Pour que la stratégie d'innovation de 2012 ne connaisse pas le même sort, il sera important qu'elle bénéficie de mesures de suivi efficaces au sein des pouvoirs publics et de la part des principales parties prenantes.

À un autre niveau, la gouvernance est étroitement liée à l'allocation des ressources, et la Suède présente un ensemble assez fragmenté de plus de 20 organismes de taille généralement moyenne finançant les activités d'innovation. Cette situation résulte de la mise en place de conseils de recherche à part entière et d'organismes de financement des technologies, une pratique qui a commencé bien plus tôt que dans la plupart des pays comparables. Une deuxième raison de ce panorama fragmenté est le fait qu'un certain nombre de conseils et d'organismes de recherche fonctionnent sous la tutelle de ministères sectoriels. En troisième lieu, une série de partenaires d'appui est apparue avec la transformation des "fonds de pension" en fondations encourageant les activités scientifiques et d'innovation, similaires à celles financées par des organisations gouvernementales. Enfin, un certain nombre de fondations privées sont apparues avec le temps.

Bien que l'on dispose ainsi d'un important réseau de financement, cette fragmentation n'est pas sans conséquences. Tout d'abord, si les objectifs et les ambitions des organismes de financement se situent à un niveau élevé, ce n'est pas le cas de leurs budgets respectifs. Même VINNOVA est très petit par rapport à sa mission et à son ambition. C'est particulièrement frappant quand on compare les budgets de ces organismes à ceux d'organisations ayant les mêmes missions dans des pays comparables (le budget de TEKES, en Finlande, représente environ trois fois celui de VINNOVA). De nombreux acteurs de taille moyenne effectuent des interventions d'importance moyenne, au niveau de chaque programme et particulièrement au niveau des unités financées.

Il semble que dans ce paysage institutionnel, le seul moyen d'obtenir des résultats non négligeables soit de faire des choses similaires en parallèle. Contrairement à ce que l'on observe au niveau des ministères, la coordination entre les organismes financeurs apparaît forte, comme le montrent les hauts niveaux de programmation conjointe (par exemple, environ la moitié du budget de VINNOVA est allouée à des programmes qui sont menés conjointement avec d'autres agences). Cela donne d'intéressantes constellations, sachant que certains programmes sont coordonnés et cofinancés par pas moins de six organismes. Il semble aussi que les mêmes personnes soient souvent membres de la direction de plus d'un de ces organismes et qu'il existe entre ces organismes une forte mobilité des dirigeants, ce qui contribue notablement à créer un réseautage informel. L'ensemble disparate de moyens de financement qui en résulte donne sans doute de la résilience au système, car il existe toujours une source de financement pour une bonne idée, mais la taille limitée des organismes et leur grand nombre limitent leur capacité d'agir comme des agents du changement capables d'orienter le système suédois vers une politique d'innovation plus intégrée et plus stratégique. Il serait profitable pour la politique suédoise d'innovation de résoudre quelques problèmes à grande échelle avec l'aide de grands acteurs et de grands instruments, et d'éviter ainsi la fragmentation et les actions parallèles.

Recommandations

Le gouvernement devrait :

- *Renforcer la direction stratégique de la politique d'innovation au niveau des pouvoirs publics*, par exemple par la mise en œuvre de la stratégie d'innovation qui vient d'être publiée. Ce faisant, les pouvoirs publics doivent tirer les leçons de la stratégie d'innovation de 2004, dont la mise en œuvre n'a pas répondu aux attentes.
- *Améliorer la coordination entre les ministères en matière de politique d'innovation* grâce à une coopération interministérielle plus étroite dans le cadre du programme de recherche et d'innovation et de la stratégie nationale d'innovation. Il convient également d'envisager un conseil intégré de la politique de recherche et d'innovation sur le modèle de l'exemple finlandais. Cette recommandation suppose comme préalable *une plus haute priorité donnée à l'innovation sur l'agenda politique du ministère de l'Entreprise, de l'Énergie et de la Communication*.
- *Produire et utiliser davantage d'information de politique stratégique*, par exemple grâce à des études d'évaluation et de prospective fondées sur une vision plus large du système d'innovation. Dans cet esprit, il conviendrait d'envisager de faire procéder à une évaluation des systèmes afin d'analyser le rôle, la fonction, la logique d'action et les résultats des acteurs suédois, parmi lesquels les principaux organismes de financement, conseils et fondations. C'est ce qui se pratique déjà en Norvège, en Autriche et en République tchèque.
- *Réduire la fragmentation du système de financement*. La collaboration entre les organismes dans le cadre des programmes (programmation conjointe) est une réaction à la fragmentation du système de financement, qui est en lui-même difficile à réformer. Néanmoins, il convient d'envisager sérieusement de consolider le système fragmenté des organismes de financement, pas seulement du point de vue des coûts de transaction, et de promouvoir un petit nombre influent de "champions de l'innovation".
- *Promouvoir quelques initiatives importantes à grande échelle, en plus des nombreuses activités de moyenne envergure, souvent parallèles, dans le domaine de l'action publique et du financement.* Comme des initiatives du passé l'on montré, cela ne va pas automatiquement à l'encontre de la règle du consensus qui est profondément enracinée en Suède. Ainsi, par exemple :
  - *Utiliser la stratégie d'innovation et la planification par étapes pour définir un petit nombre d'initiatives importantes pour promouvoir l'innovation*. Une telle approche pourrait s'inspirer des "grands défis" européens.
  - *Créer des centres plus importants et contribuer à la formation d'une véritable masse critique dans le domaine scientifique et dans la recherche collaborative*. des programmes moins nombreux mais de plus grande ampleur sont généralement plus efficaces.
- *Envisager de doubler le budget de VINNOVA si les ambitions actuelles pour cette agence sont maintenues.* Cette étude considère VINNOVA comme l'acteur essentiel de la politique d'innovation en Suède. Il existe cependant un danger que se produisent des interventions toujours plus modestes sous la bannière de systèmes toujours plus imposants, avec toujours plus de parallélisme par rapport aux autres acteurs.

Promouvoir l'innovation dans l'entreprise

En Suède, le secteur des entreprises est nettement orienté vers l'exportation et il est doté de fortes capacités de R-D et d'innovation. Pour un pays de cette taille, la Suède a su développer un extraordinaire ensemble de grandes compagnies très internationalisées, spécialisées dans divers types d'industries de moyennes et hautes technologies et de services, qui ne sauraient être comparées qu'aux compagnies suisses. Près de la moitié (45 %) de la production est exportée, et chacune des dix plus grandes entreprises du pays a réalisé en 2010 un chiffre d'affaires supérieur à 10 milliards EUR. Le secteur public a joué un rôle clé par le passé en aidant ces entreprises, souvent au sein d'une étroite coopération sous forme de "binômes de développement". Cependant, les règles internationales de la concurrence, celles qui concernant les aides de l'État par exemple, ont réduit les possibilités de poursuivre cette stratégie des "binômes de développement". En outre, la mondialisation a profondément transformé ces grandes entreprises que la Suède avait développées. La participation étrangère au capital de ces entreprises a augmenté depuis les années quatre-vingt-dix, et l'affectation des activités et des ressources qui leur sont associées se fait maintenant dans le cadre de structures d'entreprise mondialisées. Il en résulte un risque accru qu'une partie des activités de production et de recherche soit délocalisée. Il en résulte aussi que la Suède doit rivaliser avec la concurrence pour pouvoir retenir et attirer les activités économiques, entre autres la R-D des entreprises.

Il est essentiel que les entreprises suédoises qui exercent leurs activités à l'échelle internationale soient dotées d'importants réseaux de recherche et d'innovation. De ce point de vue, le secteur des services aux entreprises, très développé en Suède, l'infrastructure du savoir et les instituts de recherche (en particulier les universités) peuvent jouer un rôle plus grand encore. Différentes universités et différents instituts de recherche publics peuvent jouer des rôles différents. Cela dit, la récente fermeture d'un grand laboratoire de recherche pharmaceutique privé soulève la question de savoir comment réussir à ancrer les capacités dans des secteurs qui changent rapidement. En même temps, des exemples probants de délocalisation vers la Suède d'unités étrangères de recherche ou de production pour des raisons liées à la R-D semblent faire défaut. De telles délocalisations se sont produites vers des pays comme la Suisse ou les États-Unis, grâce à la qualité de la recherche universitaire et à des réglementations plus libérales.

À plus long terme, un secteur des PME plus fort et innovant rendrait la Suède moins dépendante vis-à-vis d'un nombre relativement petit de grandes entreprises et pourrait permettre la croissance de nouvelles entreprises. Il faudrait pour cela des conditions dignes des meilleures pratiques mondiales (voir précédemment). Une base de connaissances améliorée chez les PME suédoises innovantes serait aussi un avantage.

Les investissements en R-D par secteur se concentrent dans les grandes entreprises. En effet, plus de 80 % des dépenses intérieures de R-D des entreprises (DIRDE) sont le fait de grandes compagnies. Les DIRDE en Suède représentent 2.5 % du PIB (environ 8 milliards EUR), une des plus fortes proportions dans la zone OCDE. Les trois quarts concernent l'industrie et le quart les services. Les secteurs à hauts volumes de dépenses de R-D (2009) sont les industries mécanique, électrique et électronique (2.7 milliards EUR), l'industrie automobile (1.6 milliard EUR) et l'industrie pharmaceutique (600 millions EUR).

En même temps, les analystes et les responsables politiques reconnaissent, de plus en plus, que l'innovation ne se limite pas à la R-D. Alors que la recherche sur l'innovation relevait traditionnellement des universités, des laboratoires, des scientifiques et de la R-D, des études récentes ont mis en évidence l'importance des biens de capital intellectuel (ou actifs immatériels) utilisés dans la production et qui appartiennent aux entreprises, comme l'information sous format électronique (logiciels et bases de données), les biens incorporels innovateurs (brevets, droits d'auteur, modèles, marques commerciales) et les compétences économiques (image de marque, capital humain spécifique à l'entreprise, réseaux reliant les personnes et les institutions, et savoir-faire organisationnel rendant l'entreprise plus rentable). De nouvelles mesures et de nouveaux travaux d'analyse ont attiré l'attention sur l'ampleur croissante des investissements des entreprises dans les actifs immatériels, et il en ressort que ces investissements sont une source fondamentale de variations de la productivité et du PIB. D'après des données récentes, la Suède serait un des pays de l'OCDE dans lesquels l'investissement des entreprises dans ces actifs est le plus élevé par rapport au PIB, et cet investissement pourrait bien être à l'origine de 30 % de la croissance de la productivité de la main d'œuvre dans l'industrie suédoise entre 2000 et 2006. L'investissement dans les actifs immatériels dépend d'un certain nombre de domaines politiques, et notamment d'un vaste ensemble de conditions cadres.

À l'instar d'autres pays performants de l'OCDE comme l'Allemagne et la Suisse en Europe ou le Japon et la Corée en Asie, qui ont soutenu les grandes entreprises du secteur privé qui investissaient dans la R-D, la Suède ne recourt que modérément aux subventions pour la R-D (mesurées par la part du financement gouvernemental dans les dépenses des entreprises privées en R-D). Le portefeuille de financement suédois se limite à un nombre relativement réduit de programmes destinés chacun à une entreprise. En même temps, la Suède est un des rares pays de l'OCDE, avec l'Allemagne et la Finlande, à ne pas proposer aux entreprises des incitations fiscales à investir en R-D (comme les dispositifs de crédit d'impôt). Cela est compréhensible compte tenu de la structure de l'industrie (constituée de très grosses entreprises) et du fait que les grandes compagnies suédoises soient soumises à un régime d'impôt sur les sociétés qui favorise apparemment le réinvestissement des profits. Si le soutien direct et le soutien budgétaire fonctionnent souvent en parallèle, la mise en place d'un dispositif d'incitations fiscales implique des arbitrages. Elle peut compliquer excessivement le système d'imposition, entraîner des pertes d'efficacité et poser des problèmes de contrôle de la bonne utilisation de ces incitations. Le coût pour le contribuable peut être élevé. Si sa discipline en matière de subventions est méritoire, la Suède pourrait cependant envisager un soutien accru aux PME tout en s'efforçant de satisfaire à leurs besoins de la manière la plus efficace. Si cela doit passer par un soutien aux petites entreprises par des mesures fiscales, le dispositif doit aussi couvrir les entreprises qui ne sont pas actuellement rentables.

Le financement de l'UE constitue un soutien financier supplémentaire pour les entreprises. La forte participation des acteurs économiques suédois dans les programmes-cadres a eu pour conséquence d'importantes rentrées de fonds et elle a été un grand succès. Des secteurs de l'industrie bien organisés comme les télécommunications et la construction automobile ont utilisé avec succès les programmes-cadres pour des travaux pré-concurrentiels ou de normalisation. Les grandes compagnies continuent à participer aux programmes-cadres de cette manière. Le niveau de participation des PME est au-dessus de la moyenne de l'UE et il est comparable à celui d'autres petites économies de pointe. Néanmoins, on peut souhaiter des niveaux de participation des PME plus élevés.

Le soutien aux activités d'innovation des entreprises peut aussi prendre la forme de projets à grande échelle et de consortiums autour des grands défis, pouvant servir de plateformes et de dispositifs de focalisation pour l'innovation stratégique. La Suède a déjà défini des objectifs ambitieux concernant la lutte contre les émissions de carbone, les énergies renouvelables et la durabilité. Une telle approche peut déboucher sur des systèmes de "co-développement" solides avec des opportunités de marché pour les entreprises participantes.

Recommandations

Le gouvernement devrait :

- *Mettre en place un environnement d'innovation de premier ordre afin d'attirer et de retenir les entreprises qui innovent.* Comme mentionné précédemment, il faut pour cela des conditions-cadres excellentes, mais aussi des initiatives plus ciblées. Des initiatives locales peuvent y contribuer de façon appréciable (p.ex. à travers une infrastructure locale des TIC, des initiatives axées sur le regroupement, etc.).
- *Utiliser tous les moyens disponibles pour faire en sorte que les grandes sociétés maintiennent leurs activités de production et de recherche en Suède, dans un environnement d'innovation de premier ordre.* Il s'agit notamment d'affiner le profil des meilleures universités, par exemple grâce à de plus grands centres d'excellence (voir plus loin).
- *Faire de la croissance des PME innovantes l'objectif essentiel d'une politique d'innovation restructurée et renforcée.* Cette politique doit concerner aussi bien les jeunes PME que celles déjà bien établies. Un certain soutien public aux efforts de R-D et d'innovation de ces entreprises est nécessaire pour corriger les fréquentes carences du marché dans le secteur des PME. Il convient de veiller à soutenir les entreprises à forte croissance.
- *Envisager d'accroître le montant et le niveau de financement direct de l'innovation des PME,* par exemple en développant des programmes comme ceux de VINNOVA et de la Fondation pour la connaissance afin de soutenir le placement de diplômés de l'enseignement supérieur dans les PME. De telles initiatives peuvent permettre aux petites entreprises d'entrer dans des cycles de développement de produits et de processus plus complexes et de nouer des liens avec les universités grâce à des transferts de personnes.
- *Si de nouvelles incitations fiscales en faveur de la R-D sont envisagées, elles doivent cibler les PME, y compris celles qui ne sont pas actuellement rentables.* Il est nécessaire d'évaluer de façon critique dans quelle mesure un tel dispositif doit être proposé dans le système suédois.
- *Accorder beaucoup d'attention non seulement à l'innovation traditionnellement fondée sur la R-D mais tout autant à l'innovation hors R-D dans les entreprises, notamment l'innovation dans les services et dans les industries créatives.* Faire un effort particulier pour satisfaire aux besoins des entreprises qui sont parfois difficiles à atteindre.
- *Promouvoir les compétences en matière de conception,* qui constituent une forme d'actif immatériel, par le biais d'une attention particulière portée aux dispositifs de formation et d'enseignement destinés à équilibrer l'offre et la demande sur le marché pour les compétences en matière de conception ainsi qu'au système de droits attachés aux dessins et modèles, afin qu'ils soient facilement compris et que leur enregistrement et leur application soient simples et peu onéreux.

Équilibrer le dosage des politiques : le rôle des mesures axées sur la demande

Comme d'autres pays, la Suède dispose d'une riche panoplie de mesures de soutien axées sur l'offre permettant de compenser diverses imperfections du marché et du système, par exemple dans la production de connaissance, dans le financement de l'innovation, dans l'établissement de liens, etc. Du côté de la demande, la passation des marchés publics a joué un rôle significatif dans l'histoire d'un certain nombre de sociétés suédoises parmi les plus grosses et les plus innovantes. Cependant, les cadres juridiques actuels, notamment les règles en matière d'aide d'État, interdisent désormais un certain nombre de pratiques qui avaient cours auparavant. Ces dernières années, on a constaté un regain de tentatives d'utiliser la passation de marchés publics pour stimuler l'innovation. La Suède ne fait pas exception, et il est même soutenu que ce pays jouit d'un avantage comparatif dans ce domaine. À ce jour, toutefois, les initiatives pour promouvoir une passation de marchés de nouvelle génération, orientée vers l'innovation, ont surtout consisté en travaux préparatoires, et un petit nombre d'autres pays ont progressé davantage que la Suède. Ces travaux préparatoires ont permis de déterminer un ensemble de structures et de pratiques institutionnelles qui pourraient être modifiées ou améliorées en vue de faciliter la passation de marchés pro-innovation. Le défi qui se présente actuellement consiste pour une grande part à agir sur la base de ces résultats, de façon concertée et systématique. Ce faisant, il est important d'assurer un certain degré de normalisation et d'apprentissage structuré au niveau des autorités infranationales.

À part la passation de marchés publics axée sur l'innovation, un certain nombre de pays gèrent des programmes d'achat de services de R-D aux PME, et en Suède, Forska&Väx soutient la R-D dans les PME. Cependant, il semble qu'actuellement aucun programme ne vise à intégrer de façon systématique les PME dans le processus de marchés publics de la R-D comme le fait le SBIR aux États-Unis (d'après un rapport de VINNOVA rédigé en 2009, Forska&Väx était trop petite et trop limitée en envergure). Un véritable dispositif de type SBIR pourrait être profitable à la Suède.

Recommandations :

- *Enrichir la panoplie d'instruments traditionnelle avec des instruments axés sur la demande* comme la passation de marchés axée sur l'innovation, par exemple dans les technologies "vertes".
- *Faire la synthèse des enseignements et des recommandations découlant des diverses enquêtes et activités pilotes relatives à la passation de marchés pro-innovation et procéder à leur mise en application.* Il est important de contrôler étroitement et d'évaluer l'efficacité et l'efficience de la passation de marchés axée sur l'innovation lorsqu'elle est instituée à une échelle suffisamment grande.
- *Étudier les moyens d'assurer une normalisation et un apprentissage structuré dans les passations de marchés pro-innovation au niveau des autorités infranationales.*
- *Veiller à ce que des informations et conseils complets soient à la disposition des organismes chargés des marchés publics, y compris au niveau des régions.* De façon plus générale, il convient de porter une grande attention à la clarification des circonstances dans lesquelles la passation de marchés axée sur l'innovation au niveau infranational devrait être viable. Non seulement certains compétences et certaines formes de savoir-faire spécifiques sont généralement moins présentes au niveau infranational, mais les économies d'échelle nécessaires au succès de certains types de passation de marchés pro-innovation risquent d'y faire défaut.

- *Apprécier dans quelle mesure la mise en œuvre d'un véritable projet de type SBIR représenterait un complément significatif à la série existante d'instruments disponibles de soutien à l'innovation* (si en comblant une lacune dans les services actuels, une telle initiative aurait des chances de faire progresser le niveau global d'innovation dans les PME à un coût raisonnable).

Créer une masse critique et promouvoir l'excellence et l'utilité dans la recherche du secteur public

En Suède, les activités de recherche sur fonds publics ont lieu principalement dans les établissements d'enseignement supérieur et se concentrent dans un petit nombre d'universités. Les DIRDES, qui représentent 0.9 % du PIB en 2010, sont les plus importantes de l'OCDE. Environ 60 % du total du financement des DIRDES va à cinq universités. À titre de comparaison, le secteur des instituts de recherche publique est relativement réduit, sachant qu'il représente environ 3 % des DIRDE. La productivité scientifique des chercheurs suédois, mesurée par le nombre de publications dans les principales revues, est forte selon les normes internationales, de même que la qualité scientifique telle qu'elle est mesurée par la fréquence des citations, encore que la Suisse fasse considérablement mieux.

Les établissements d'enseignement supérieur

Il existe en Suède un certain nombre d'universités de haut niveau, internationalement reconnues, dotées de groupes de recherche internationalement reconnus et bien intégrés dans les réseaux. Quatre de ces universités, à savoir Karolinska, Lund, Stockholm et Uppsala, font régulièrement partie des 100 premiers établissements d'enseignement supérieur dans les classements mondiaux (comme le *Times Higher Education Supplement* et le classement de Shanghai). Au cours des dernières décennies, un certain nombre de nouvelles universités ont été ajoutées au système d'enseignement supérieur suédois. Plusieurs ont acquis une réputation dans un créneau particulier en termes de géographie ou de spécialisation. Ces nouvelles universités présentent aussi d'intéressants profils de collaboration avec l'industrie locale, avec des petites entreprises comme avec des filiales de sociétés multinationales.

Dans la structure suédoise de soutien, le financement de la recherche universitaire revêt une grande importance. Le financement direct d'État des établissements d'enseignement supérieur a représenté ces dernières années le flux de revenus à la croissance la plus rapide et il correspondait à 47 % du revenu total de la recherche (y compris l'aide aux doctorants) en 2010. Le reste du financement des établissements d'enseignement supérieur provient en grande partie du gouvernement ou d'autres sources publiques sous forme de financement de projets. L'agence qui finance la recherche, à savoir le Conseil suédois de la recherche (*Vetenskapsrådets – VR*), est bien pourvue et il existe un certain nombre d'autres acteurs pour des domaines particuliers (p.ex. FORMAS pour la durabilité, FAS pour la recherche liée au travail, STEM pour l'énergie, ou Riksbankens RJ pour les sciences sociales et les sciences humaines) ou pour des types d'activités plus spécifiques. Un organisme de financement spécialisé, la Fondation pour la connaissance, apporte un soutien aux instituts universitaires pour la collaboration avec l'industrie dans leurs activités de recherche et d'enseignement. La proportion de DIRDES financées par l'industrie a diminué au cours de la dernière décennie pour ne représenter que 4.5 % en 2009, soit environ les deux tiers des moyennes de l'OCDE (6.3 %) et de l'EU27 (6.4 %).

Un instrument de financement très utilisé est le “programme des centres”. Dans les grandes lignes, on en distingue deux types : les centres “d’excellence”, qui reflètent l’excellence scientifique, et les centres “de compétence” pour la recherche plus appliquée et en collaboration avec l’industrie. Ces centres font juridiquement partie des universités qui les abritent. En Suède, les centres des deux types disposent rarement d’un budget annuel de plus de 1 million EUR, ce qui est très réduit par rapport aux autres pays. La conséquence est que l’on trouve une série de centres similaires de taille moyenne dans chacune des meilleures universités. Ces centres offrent d’excellentes conditions de travail et une bonne exposition, mais il leur manque souvent la masse critique qui leur permettrait de stimuler l’innovation au sein de ces universités.

Compte tenu de ses points forts dans la recherche industrielle et scientifique, la Suède bénéficie en principe d’excellentes possibilités d’établir des liens solides et fructueux entre l’industrie et la recherche universitaire. Dans le passé, une stratégie industrielle centrée sur les “binômes de développement” a favorisé une collaboration étroite entre les plus grandes firmes suédoises et le secteur public, qui incluait dans une certaine mesure les établissements d’enseignement supérieur et les instituts de recherche publics. Aujourd’hui, inspirés par une logique de système d’innovation, plusieurs organismes de financement gèrent des programmes destinés à encourager les liens entre industrie et université. Ainsi, par exemple, VINNOVA propose tout un ensemble de programmes de collaboration entre science et industrie, de transferts de technologie et d’initiatives connexes dans le domaine de l’entreprenariat et de la coopération entre les entreprises, tandis que la Fondation pour la connaissance finance des recherches menées dans les nouvelles universités suédoises dans la mesure où l’industrie y participe activement et apporte un financement équivalent. Souvent, ces programmes sont directement destinés aux universitaires ou autres acteurs de la recherche publique qui soumettent des demandes et reçoivent le financement, la participation de l’industrie se faisant généralement sous forme de contributions monétaires ou en nature.

En même temps, en vertu de ce que l’on appelle le “privilège du professeur”, les établissements d’enseignement supérieur disposent d’infrastructures relativement peu développées pour la commercialisation de leur R-D et leur performance en matière de brevets est faible. Un système de droits exclusifs pour les inventeurs présente des avantages en termes d’essaimage ou de réduction de la lourdeur administrative et des coûts d’infrastructure, mais il a aussi ses inconvénients. Ainsi, par exemple, les établissements d’enseignement supérieur n’ont pas une bonne connaissance de la propriété intellectuelle générée à partir de leurs ressources et ne peuvent pas constituer un portefeuille de propriétés intellectuelles et en tirer un flux de revenus. Le principal problème avec les systèmes de gestion des droits de propriété intellectuelle des universités, quels qu’ils soient, est qu’ils doivent être mis en œuvre de façon tout à fait professionnelle, par les meilleurs spécialistes et dans le cadre d’une vision à long terme. L’expérience internationale montre que les insuffisances sont courantes dans ce domaine, et qu’il vaut sans doute mieux, dans ce cas, se passer de ces systèmes.

Il existe un ensemble d’offices pour l’innovation nouvellement créés dont le but est de promouvoir davantage les transferts de connaissance des établissements d’enseignement supérieur en aidant les chercheurs qui souhaitent commercialiser les résultats de leurs travaux ou même créer des sociétés dérivées. S’il est trop tôt pour évaluer leur performance, on peut cependant constater qu’ils ne valent pas les véritables bureaux de transfert de technologie que l’on trouve dans un certain nombre d’établissements d’enseignement supérieur dans le monde entier. Il est certain qu’il

existe des possibilités considérables de mieux exploiter les mécanismes de transfert de connaissance dans les établissements d'enseignement supérieur. Cependant, les efforts dans ce sens doivent prendre en compte le fait que les bénéfices de la recherche dans les établissements d'enseignement supérieur sont à rechercher essentiellement dans les compétences avancées qu'elle génère, et qui sont très intéressantes pour les entreprises spécialisées dans les hautes technologies, en supposant bien évidemment une forte mobilité et de nombreux contacts intersectoriels. Une grande partie des bénéfices de la recherche universitaire s'incarne dans les étudiants et les chercheurs, ce qui indique qu'une coopération étroite avec les entreprises et les acteurs sociaux est importante, dans la recherche comme dans l'enseignement et la formation, et qu'il faut des conditions favorables à la mobilité.

Les établissements d'enseignement supérieur peuvent aussi trouver une autre source de financement auprès du Programme cadre de l'UE, dans le contexte d'un système déjà généreux. Il convient de noter en particulier deux récentes lignes de financement européennes : la Suède a remporté un grand succès lors du premier lancement des communautés de la connaissance et de l'innovation avec l'Institut européen de technologie, et elle a présenté une bonne performance dans le cadre des demandes qu'elle a soumises au Conseil européen de la recherche.

Recommandations

Le gouvernement devrait :

- *Aider les universités à devenir des acteurs plus forts et plus proactifs du système d'innovation.* Il convient de poursuivre le travail de profilage des universités et le renforcement du leadership organisationnel. En même temps, les établissements d'enseignement supérieur doivent être plus fortement encouragés à favoriser en interne la constitution d'une masse critique. Il est important de promouvoir une différenciation à l'intérieur de ces établissements et entre ces établissements, d'aller vers une plus grande spécialisation et de constituer des centres d'excellence. Des centres plus grands et mieux structurés peuvent aussi améliorer les échanges avec l'industrie (notamment les PME) et le public. Il convient d'encourager les universités à être davantage tournées vers l'extérieur et vers l'entreprise, d'accroître le nombre et la proportion des contrats avec l'industrie, de développer des centres d'excellence et de recourir à une stratégie active en matière de propriété intellectuelle.
- *Continuer à accroître le soutien à la R-D dans les instituts universitaires tout en conservant leur caractère propre vis-à-vis des établissements universitaires leaders en matière de recherche*. En même temps, il convient d'envisager de regrouper des instituts universitaires en entités uniques pour disposer d'une masse critique et y incluant éventuellement des instituts de recherche. Ce sera particulièrement important pour la gestion des impacts de l'évolution démographique qui menace l'existence de certains petits instituts.
- *Récompenser l'excellence dans la recherche.* La Suède progresse lentement en ce qui concerne l'évaluation des travaux de recherche pour justifier les subventions globales. Disposant d'une plus grande autonomie, les établissements d'enseignement supérieur doivent aussi être soumis à des régimes de responsabilisation plus affirmés grâce à des évaluations des travaux de recherche.

- *Faire en sorte d'attirer et de retenir davantage les meilleurs chercheurs étrangers, en particulier dans les universités*. Prendre modèle sur le secteur des EPF en Suisse (l'ETH de Zurich et l'EPF de Lausanne) pour le recrutement des universitaires en fonction de l'excellence de leurs travaux.
- *Réviser la manière dont s'applique le "privilège du professeur"*. Lorsqu'un système de détention de la propriété intellectuelle par les universités est mis en place, il faut qu'il corresponde aux meilleurs modèles du monde. En même temps, il convient de procéder à un examen anticipé des bureaux d'innovation créés par les établissements d'enseignement supérieur.
- *Continuer d'axer la politique sur les partenariats collaboratifs tout en tirant les enseignements de l'expérience pour améliorer certains des instruments.* En particulier, s'efforcer de mieux lier les PME aux producteurs de connaissance doit être une priorité.
- *Renforcer les liens entre les établissements d'enseignement supérieur et le secteur des entreprises privées dans les programmes d'enseignement,* par exemple en élargissant le programme VINNPRO pour créer des établissements d'enseignement supérieur de second cycle avec une forte participation des entreprises.

Les instituts publics de recherche

Il existe en Suède deux grands types d'instituts publics de recherche. Il y a d'une part les instituts de recherche qui sont plus ou moins des organismes gouvernementaux mais qui ont l'autorisation de faire payer les services rendus, comme l'Agence suédoise de recherche sur la défense (FOI) et le VTI, spécialisé dans l'analyse et la construction des systèmes de transport. Les principaux clients de ces organismes sont respectivement le ministère de la défense et le ministère des transports, et ils ne seront pas abordés longuement dans l'étude. Il y a d'autre part la recherche industrielle, dont la principale mission est de fournir des services de R-D au secteur privé en Suède. En principe, les entreprises du secteur privé achètent des services de R-D à ces instituts et l'État finance une ordonnance couvrant le développement des installations et des compétences. Le travail de ces instituts de recherche est largement régi par la demande et il est censé servir d'interface entre la recherche universitaire et le développement des produits dans le secteur des entreprises.

Les instituts de recherche qui se consacrent à la recherche industrielle ont été récemment regroupés sous un holding, RISE, afin d'améliorer l'orientation stratégique, de réunir les ressources et d'exploiter les complémentarités. On distingue quatre grandes sous-structures au-dessous du petit holding RISE, chacune rassemblant un certain nombre d'instituts regroupés autour de thèmes comme par exemple les TIC. Ces instituts ont généralement des approches commerciales différentes, en fonction du secteur desservi. Les modèles vont du contrat de test aux réels consortiums de recherche. Pris ensemble, ces instituts emploient plus de 2 100 personnes, dont plus du tiers sont titulaires d'un doctorat.

Depuis quelques années, le soutien gouvernemental aux instituts de recherche se renforce. Un des mécanismes spécifiques comprend le programme de doctorat du Centre d'excellence de VINNOVA, un autre programme spécifique aux instituts RISE. Un certain nombre d'instituts parmi les plus efficaces travaillent dans un cadre "triangulaire", avec les universités de RISE et le secteur des entreprises. Le développement de liens entre les universités et RISE est donc considéré comme une opportunité, certaines universités

adoptant une vision positive de ce genre de collaboration. Les communautés de la connaissance et de l'innovation de l'Institut européen de technologie en sont un bon exemple dans le domaine des TIC, et elles reposent sur une collaboration prolongée avec Ericsson, les instituts RISE et l'Institut royal de technologie KTH. Les stratégies de regroupement et les groupes de recherche de second rang des multinationales représentent des possibilités intéressantes de partenariat. RISE bénéficie aussi des mesures de politique publique au niveau régional, les instituts RISE ayant participé avec succès aux consortiums de VINNVÄXT.

Recommandations

Le gouvernement devrait :

- *Assurer la stabilité de la structure RISE et lui permettre de croître modérément dans la mesure où elle répond directement aux besoins des PME ou des secteurs dominés par les PME.*
- *Étudier les possibilités de fusion entre les instituts et les universités (les plus petites) dans la mesure où un tel changement peut permettre de faire émerger des acteurs régionaux puissants ayant une orientation thématique claire.*
- *Faire en sorte, comme mesure supplémentaire peu coûteuse pour encourager l'investissement des entreprises dans les actifs immatériels, que les dispositifs qui encouragent ou facilitent l'accès des entreprises à l'information et aux conseils concernant la recherche ou la technologie, leur permettent aussi l'accès à des services, conseils et informations non technologiques* (p.ex. gestion de la conception, de la commercialisation, de la logistique et des ressources humaines). Des travaux de recherche récents sur les échanges de connaissances entre les sciences, l'ingénierie et les sciences humaines militent aussi pour l'extension de ces dispositifs aux domaines touchant aux actifs immatériels.

Renforcer la politique régionale d'innovation et son alignement sur la politique nationale

La Suède privilégie nettement l'équité spatiale et un développement régional équilibré, et depuis plusieurs décennies, elle fait en sorte de développer les régions les plus isolées et les moins favorisées. Certaines de ces régions tirent profit d'une base industrielle traditionnelle solide dans des secteurs comme les mines et la métallurgie, ou le bois et le papier. D'autres se sont spécialisées dans des niches plus étroites comme les composants automobiles ou certains services spécifiques. Néanmoins, les disparités entre les régions restent fortes et les régions en plein essor dans le sud du pays continuent d'absorber les talents et les opportunités.

Depuis une vingtaine d'années, les politiques régionales d'innovation ont pris de l'importance dans la plupart des pays de l'OCDE. À partir d'organismes de coordination informels et de mesures de regroupement, les approches régionales de l'innovation en Suède sont devenues plus formalisées et ont pris une importance croissante dans l'agenda politique global pour l'innovation. Atteindre une plus grande équité territoriale reste un objectif politique important, mais à la combinaison d'instruments et de mesures distributives et infrastructurelles sont venues s'ajouter des mesures visant à développer les capacités régionales endogènes d'innovation. Les fonds structurels européens et les activités territoriales dans le cadre des politiques d'innovation de l'UE ont encore stimulé ce changement. Alors que durant les périodes précédentes, le financement des régions par

l'UE se caractérisait par un soutien aux infrastructures physiques et par une orientation générale en faveur des régions les plus pauvres ou les plus isolées, la période en cours 2007-2013 met plus l'accent sur l'innovation et inclut formellement le pays tout entier.

Les fonds structurels européens sont administrés par l'Agence suédoise pour la croissance économique et régionale (*Tillväxtverket*), qui gère les demandes, prend les décisions en matière de financement et assure le contrôle. D'après une étude récente des mesures de soutien à l'innovation et à l'entreprenariat, un certain nombre de ces mesures sont trop globales et insuffisamment adaptées aux conditions et aux destinataires, qui varient considérablement d'une région à une autre. Les instituts d'enseignement supérieur et les universités en sont les principaux bénéficiaires, mais c'est souvent aux dépens des résultats en termes d'innovation en faveur de la recherche, et il n'y a pas suffisamment d'évaluation fonctionnelle ni de culture de l'apprentissage.

Tillväxtverket est aussi le plus grand financeur national des dispositifs régionaux pour l'innovation, qui sont souvent orientés vers le soutien à l'innovation dans les entreprises. Un certain nombre d'autres agences nationales ont aussi orienté leurs programmes d'innovation au niveau régional, notamment la Fondation pour la connaissance et VINNOVA. Cette fragmentation permet l'expérimentation, mais elle engendre des problèmes de coordination. Ces problèmes sont encore aggravés par le fait que la situation des régions elles-mêmes, en termes de développement, est variable. La plupart des régions sont faiblement développées, sachant que les mandats stratégiques et les ressources se situent aux niveaux national et municipal. À la fin des années quatre-vingt-dix, Skåne et Västra Götaland ont obtenu le statut de "régions pilotes", des autorités régionales directement élues assumant la responsabilité du développement régional à la place des organismes étatiques. Ce changement a encouragé une approche plus fortement ascendante qui a abouti à la mobilisation d'autres acteurs régionaux et à la formulation de stratégies de développement régional et d'innovation. D'autres mesures de politique régionale au milieu des années 2000 ont été moins ambitieuses et ont abouti à la formation d'organismes de coordination régionale (plus faibles) dans d'autres régions. Cette forme de régionalisation traduit le fait que les acteurs de la politique nationale sont confrontés à une variété d'acteurs différents, qui ont des mandats différents dans des régions différentes.

Recommandations

Le gouvernement devrait :

- *Étudier les moyens de mieux adapter les initiatives européennes et nationales aux spécificités régionales.* Il faudra pour cela renforcer les compétences en matière de politique d'innovation au niveau régional.
- *Encourager un vaste ensemble d'acteurs, au-delà des universités et des instituts d'études supérieures, à assumer des rôles de leaders dans les programmes régionaux d'innovation.* Les résultats en termes d'innovation devraient s'en trouver améliorés.
- *Promouvoir une culture de l'apprentissage autour des mesures de politique d'innovation au niveau régional.* Les évaluations doivent aller au-delà des procédures et constituer des opportunités d'apprentissage mutuel entre les différents acteurs régionaux. Il faut aussi de vastes opportunités d'apprentissage au niveau international à partir des politiques régionales d'innovation.

Renforcer l'innovation dans le secteur public et l'innovation sociale

Les programmes d'innovation ont généralement porté sur les progrès des sciences et techniques qui favorisent l'innovation dans les entreprises, en particulier l'innovation au niveau des produits dans les entreprises manufacturières. Or, il est aujourd'hui admis que ce champ d'application est trop étroit pour un programme national d'innovation. En particulier, il ne permet pas d'exploiter la dynamique et les bénéfices potentiels de l'innovation dans le secteur public, et plus généralement dans la société.

Le secteur public est un des plus gros prestataires de services dans un certain nombre de pays de l'OCDE, et la prestation de services représente une grande part des dépenses gouvernementales. La pression sur le secteur public en faveur de l'innovation et du changement s'accroît à mesure que de nombreuses "tâches publiques" (comme l'administration) progressent en volume ou en complexité, contrairement aux ressources disponibles.

La connaissance de la façon dont les pays ont mis en œuvre des approches innovantes dans le secteur public reste fragmentée, et une définition commune de ce que signifie l'innovation pour les organismes du secteur public fait défaut. Il convient d'en faire davantage pour pouvoir comprendre quelle est la limite entre réforme du secteur public et innovation. La Suède a joué un rôle actif en s'efforçant de développer la base de connaissance, par exemple à travers les efforts conjoints des pays nordiques pour améliorer la mesure de l'innovation dans le secteur public. En outre, les pouvoirs publics ont récemment créé un Conseil national pour l'innovation et la qualité dans le secteur public afin de faire progresser l'efficience et la qualité des activités publiques aux niveaux national, régional et local. Ce Conseil a pour objectif de soutenir et stimuler l'innovation et le changement dans les services publics par le biais d'analyses et de propositions de mesures pour promouvoir l'innovation et le développement dans le secteur public. Il devrait remettre son rapport vers le milieu de l'année 2013.

Dans le domaine de l'innovation sociale, la Suède a acquis au plan international la réputation d'être socialement responsable et soucieuse de l'environnement. En 2008, la Fondation pour la connaissance a commencé à financer des programmes de recherche et de formation dans ce domaine, et depuis, elle a subventionné la création et l'activité du Forum pour l'innovation sociale (Forum for Social Innovation Sweden). Ce forum réunit des acteurs du monde universitaire, des entreprises, du secteur public et du monde associatif qui veulent promouvoir l'innovation sociale. En 2012, il présentera un aperçu d'une stratégie pour un travail sur l'innovation sociale et l'entreprenariat social dans l'avenir.

Recommandations

Le gouvernement devrait :

- *Élargir le cadre de la politique d'innovation de telle sorte qu'il couvre le secteur public et l'innovation sociale.* La politique suédoise d'innovation continue de privilégier nettement le soutien à la R-D et à l'innovation dans les entreprises manufacturières, mais il convient d'élargir cette vision pour qu'elle recouvre tous les aspects de l'innovation.
- *Continuer d'œuvrer pour une meilleure base conceptuelle et empirique pour la mesure et la promotion de l'innovation dans le secteur public.*
- *Développer et mettre en œuvre des expérimentations dans le secteur public afin de promouvoir l'innovation.*

- *Faire en sorte que le savoir-faire relatif à l'innovation dans le secteur public atteigne les niveaux régional et municipal. De même, faire en sorte que les enseignements tirés des expérimentations aux niveaux régional et municipal soient largement partagés, éventuellement par le biais de forums de partage de la connaissance nouveaux ou existants.*
- *Mettre au point des modèles d'entreprise pour une innovation sociale durable, en tenant compte des pratiques internationales dans ce domaine.*

Maximiser les bénéfices de l'internationalisation de la R-D et de l'innovation

Le succès des systèmes nationaux d'innovation ne peut se poursuivre que s'ils sont étroitement liés et intégrés aux réseaux internationaux d'échange de connaissance. Il en est ainsi plus particulièrement pour des petites économies comme la Suède, où l'accès aux nouvelles connaissances, aux technologies et au savoir-faire produits et développés à l'extérieur des frontières nationales joue un rôle crucial dans le succès de l'innovation. Une perspective internationale devient plus nécessaire aussi en raison de la nécessité de rivaliser avec les autres pays pour attirer et retenir les investissements intensifs en connaissance dans un contexte de mondialisation croissante. Enfin, pour répondre à ce que l'on appelle les "grands défis", dont l'échelle et le champ s'étendent bien au-delà des frontières nationales, il est nécessaire de participer à la détermination des priorités d'action et aux actions coordonnées au niveau international.

La Suède est déjà très liée à l'international par ses relations commerciales, par son investissement direct étranger et par sa collaboration à la R-D transfrontalière. Une forte orientation export et les activités des grandes entreprises très internationalisées ont été des facteurs essentiels du développement économique de la Suède, et les firmes suédoises sont aujourd'hui bien implantées dans les chaînes de valeur mondiales. Que ce soit sur le critère de ses échanges commerciaux et de ses flux d'investissement internationaux ou sur celui de la présence importante des entreprises suédoises à l'étranger et des entreprises étrangères en Suède, la Suède se classe parmi les dix premiers pays dans la plupart des études comparatives.

Par le jeu des fusions et des acquisitions, plus particulièrement au cours de ces deux dernières décennies, un certain nombre de sociétés suédoises sont devenues des filiales de grandes compagnies multinationales ayant leur siège à l'étranger. Aujourd'hui, en Suède, environ un tiers de la R-D des entreprises est effectué par des entreprises à capitaux étrangers ou par des filiales étrangères. En même temps, les grandes firmes suédoises continuent d'étendre leurs activités à l'étranger, en particulier dans la production, mais aussi dans la R-D. Les 20 plus grosses compagnies "suédoises", abstraction faite de la nationalité de leurs propriétaires, investissent presque autant dans la R-D à l'étranger qu'en Suède. Les stratégies d'entreprise des firmes internationalisées dépendent de divers facteurs dont seule une petite partie peut être influencée par la politique gouvernementale. Outre les conditions cadres générales pour l'innovation, ces facteurs comprennent la disponibilité de compétences de haut niveau et d'une infrastructure de pointe pour la recherche, et la présence de solides réseaux de sociétés, de chercheurs du secteur public, d'établissements d'enseignement et de décideurs gouvernementaux.

Comme dans un certain nombre de pays de l'OCDE, le principal "échec" de l'internationalisation dans le secteur des entreprises concerne les PME, qui souvent ne disposent pas des ressources qui leur permettraient de pénétrer d'elles-mêmes sur les marchés étrangers. La chambre de commerce suédoise est particulièrement active dans le

soutien et la promotion du commerce des PME. VINNOVA considère le progrès de l'internationalisation de ses divers programmes de regroupement comme un moyen possible de permettre aux PME à haut technologie de pénétrer les marchés étrangers, bien que cette possibilité semble plutôt limitée. En même temps, Invest Sweden a réalisé des travaux exploratoires avec les parcs scientifiques, en améliorant les possibilités d'alliances stratégiques avec des sociétés étrangères et d'investissements de sociétés étrangères.

La collaboration internationale dans la R-D est développée, et elle a pris encore de l'ampleur par suite d'une forte participation aux programmes-cadres de l'UE. Aujourd'hui, en Suède, environ 55 % des revues académiques de premier plan sont publiées avec la collaboration de chercheurs étrangers, ce qui représente une forte proportion par comparaison au niveau international.

Contrairement à l'Allemagne, par exemple, la Suède n'a pas encore élaboré une stratégie globale d'internationalisation dans le domaine de la recherche et de l'innovation, même si l'idée de le faire est déjà étudiée depuis un moment. Les partisans de cette idée jugent nécessaire d'adopter une approche plus stratégique et plus coordonnée de la coopération et des liens internationaux, afin de garantir la cohérence et la synergie entre les activités de promotion de la recherche et de l'innovation au plan national et au plan international et de veiller à ce que la politique publique ajoute de la valeur à l'importante collaboration internationale déjà existante entre les individus, les organismes et les entreprises. Dans ce domaine, on peut citer la coopération fructueuse et de longue date entre les pays nordiques, la forte participation de la Suède aux programmes-cadres de l'UE, les accords bilatéraux avec des puissances scientifiques dominantes ou émergentes comme par exemple les États-Unis et la Chine, et le programme de recherche de l'Agence suédoise de coopération internationale pour le développement.

Recommandations

Le gouvernement devrait :

- *Réfléchir à la mise au point d'une stratégie explicite d'internationalisation pour la R-D et l'innovation*. Cette stratégie devra définir de façon explicite des orientations et des actions pour promouvoir l'internationalisation, mais ces orientations et ces actions doivent être pleinement intégrées aux politiques et aux programmes existants. Une telle stratégie, tout en donnant des orientations "descendantes", doit aussi respecter les importantes activités "ascendantes" qui devront se poursuivre pour alimenter un système d'innovation florissant.
- *Envisager l'élaboration d'une stratégie nationale explicite ciblant la recherche et l'innovation à l'échelon de l'UE*. Cette stratégie pourrait faire partie d'une stratégie plus vaste d'internationalisation, mais elle nécessiterait une attention particulière compte tenu de l'importance et de l'influence de plus en plus grandes du financement européen dans le paysage suédois de l'innovation.
- *Étudier activement divers moyens d'intensifier l'internationalisation des PME*. Il s'agit d'un problème à multiples facettes avec diverses solutions possibles, et qui concerne toute une série d'organismes. Une stratégie d'ensemble serait utile pour encourager les collaborations dans la recherche d'une combinaison de solutions.
- *Continuer à renforcer les liens avec les centres d'innovation mondiaux existants et émergents*. L'essor des pays du Sud-est asiatique et d'autres économies en développement rapide rend nécessaire une orientation plus large vers l'internationalisation sans oublier qu'il reste important d'entretenir des liens forts avec l'Europe et l'Amérique du Nord.

Notes

1 Image reprise de l'économiste Moses Abramovitz par Lennart Schön, dans « Technological Waves and Economic Growth – Sweden in an International Perspective », Circle, Lund University Paper No. 2009/06, document sur lequel repose en partie la présente section.

2 La Suède s'est jointe à l'Union européenne en 1995 en même temps que l'Autriche et que son voisin la Finlande mais elle a décidé de rester en dehors de l'Union monétaire européenne.

Chapter 1

Economic performance and framework conditions for innovation

This chapter provides an overview of Sweden's macroeconomic performance. It highlights salient features of Sweden's economy – openness to international trade and foreign direct investment integration in global markets – and sketches out patterns of structural change in production and trade. It also looks at the current state of framework conditions as they relate to entrepreneurship and innovation. It concludes with a discussion of the role of innovation in Sweden's economic development in the longer term and highlights new trends in innovation as well as the increasing role of knowledge-based capital.

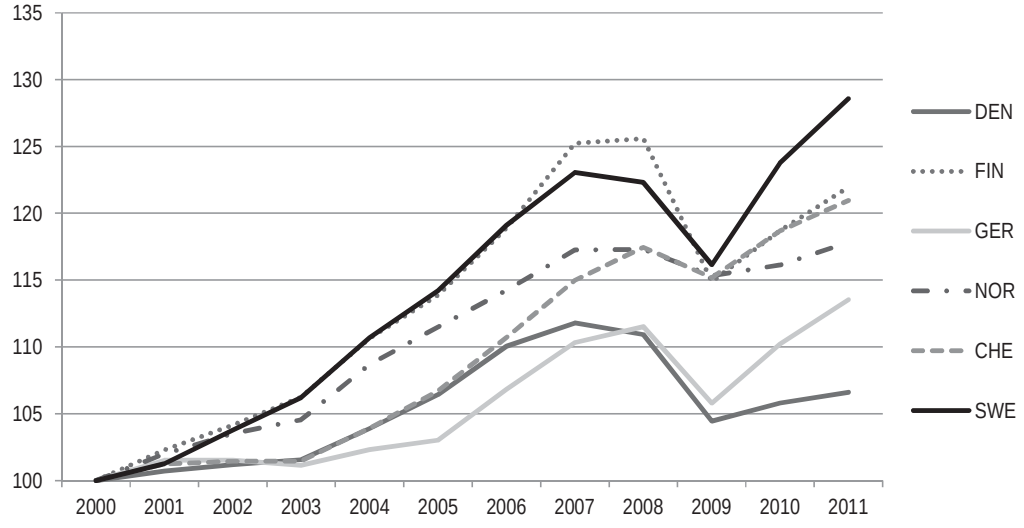
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Sweden can look back at an extraordinarily successful history of economic and social development. It started the industrialisation process as a relatively poor, resource-based country in the mid-nineteenth century and is now an advanced society with a modern welfare state widely referred to as the "Swedish model". On various counts Sweden ranks among the world's most innovative countries today. It overcame the limitations of a small domestic market through a high degree of internationalisation, not least through the emergence of large Swedish enterprises. Innovation has long been a pillar of Sweden's development, even before innovation was explicitly highlighted as a key driver of economic growth and social development. Innovation is also the key to Sweden's future in a globalised world. Excellent framework conditions for innovation are now necessary for a flourishing, innovative economy and society.

1.1. Macroeconomic performance and productivity growth

Since the turn of the millennium the Swedish economy has been very dynamic. Gross domestic product (GDP) expanded more rapidly than in advanced comparator countries, although Finland outperformed Sweden during a very short period prior to the recent financial and economic crisis (Figure 1.1). Like other small open economies that are deeply integrated in international markets, Sweden was harder hit than many OECD member countries by the economic crisis of 2008-09. Although Sweden initially experienced a sharp downturn (GDP contracted by around 5% in 2009), it rebounded quickly: its economy grew significantly faster than that of the OECD area as a whole in both 2010 and 2011. However, in the context of the global economic slowdown, real GDP growth started to slow in late 2010. Growth is expected to remain modest in 2012, albeit significantly higher than in many other European countries, and is projected to pick up in 2013 and 2014 (OECD, 2012a). Labour market participation was stronger during the crisis than in many other OECD economies. Employment has grown since late 2009, and the unemployment rate has begun to fall from about 8.4% in 2010, but remains stubbornly high.

Figure 1.1. GDP growth performance before and after the crisis



Note: Real GDP per capita in US dollars at constant prices and constant purchasing power parities.

Source: OECD National Accounts Statistics (databases), October 2012.

Sweden's economic and institutional conditions may be more resilient than those of many European counterparts. It has:

- *Relatively strong public finances.* At 49.2% of GDP in 2011, the level of general government gross debt is far below the EU average. The government intends to achieve a budget surplus averaging 2% of GDP over the economic cycle. Sound public finances allowed the governing coalition to introduce stimulus measures, mainly focused on the labour market, during the crisis period. In the event of a marked worsening of the international economic situation Sweden has sufficient fiscal resources to inject additional stimulus. A proposed increase in the age of voluntary retirement could further strengthen fiscal balances if implemented.
- *A relatively robust banking sector.* Responses to a severe banking crisis in the early 1990s helped strengthen the financial system. In response to the global financial crisis in 2008-09, the government broadened its deposit-guarantee scheme and introduced financial stabilisation measures. Sweden has little direct exposure to the sovereign debt of the most severely affected euro-zone economies. However, OECD and other analysts have pointed to risks relating to the concentration of the financial system, the close links between certain banks and firms, the geographical and currency composition of Swedish bank assets and liabilities, as well as banks' relatively high dependence on short-term wholesale funding.
- *Competitive exports*. However, the outlook for export growth is weak, owing to recessive economic conditions in many of Sweden's trading partners. The country's external accounts are healthy overall. The current account has been in surplus for some years, driven by high public- and private-sector savings.
- *Low price inflation*. It is estimated that the consumer price index, while standing at 3.0% in 2011, will be around 1.0% in 2012. There is scope for more expansive monetary policy should the downturn worsen.

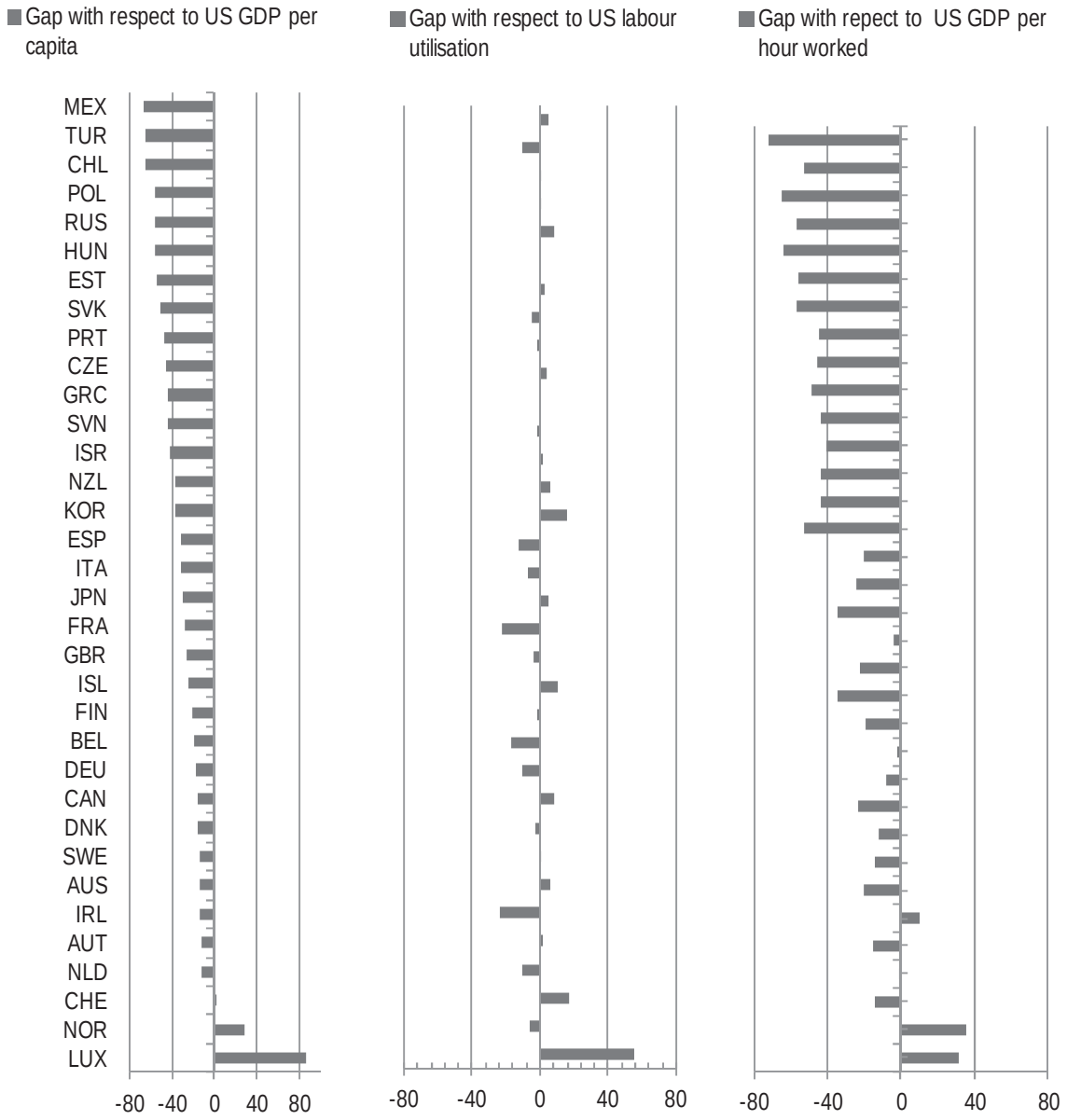
The 2012 budget includes stimulus-oriented infrastructure investments in roads and railway maintenance, a package of labour-market measures, and steps to strengthen the welfare system. The government aims to use tax cuts and reform of benefits to improve economic incentives to work, to reduce the state's role in the economy by privatising some of its majority holdings in companies, and to open product markets to wider competition.

Overall, Sweden has performed well over most of the past two decades, following an extended period of sluggish growth (see section 1.4.1). As a result it has regained a place among the countries with the highest income per capita in the OECD area and stands out in terms of a high level of welfare (Jones and Klenow, 2010), with low inequality and high life expectancy (OECD, 2011a). Sweden also performs outstandingly in overall well-being and ranks among the leaders in many areas of the OECD's Better Life Index.[1]

Yet, despite its strong economic performance over much of the past two decades, Sweden has not been able to close the gap in GDP per capita *vis-à-vis* the United States and other high-income economies (only Switzerland, Norway and Luxembourg surpass the United States in GDP per capita). In 2011, Sweden ranked 8th among OECD countries in terms of GDP per capita, at 86% of the level of the United States (Figure 1.2), a much smaller gap than for many other OECD countries. Compared to Sweden, the Netherlands, Austria and Ireland have slightly higher levels of GDP per capita, while Denmark and Canada have slightly lower levels. Finland's lag *vis-à-vis* the United States is above 20%, and the United Kingdom's is 26%.

Figure 1.2. Income and productivity levels, 2011

Percentage point differences with respect to the United States

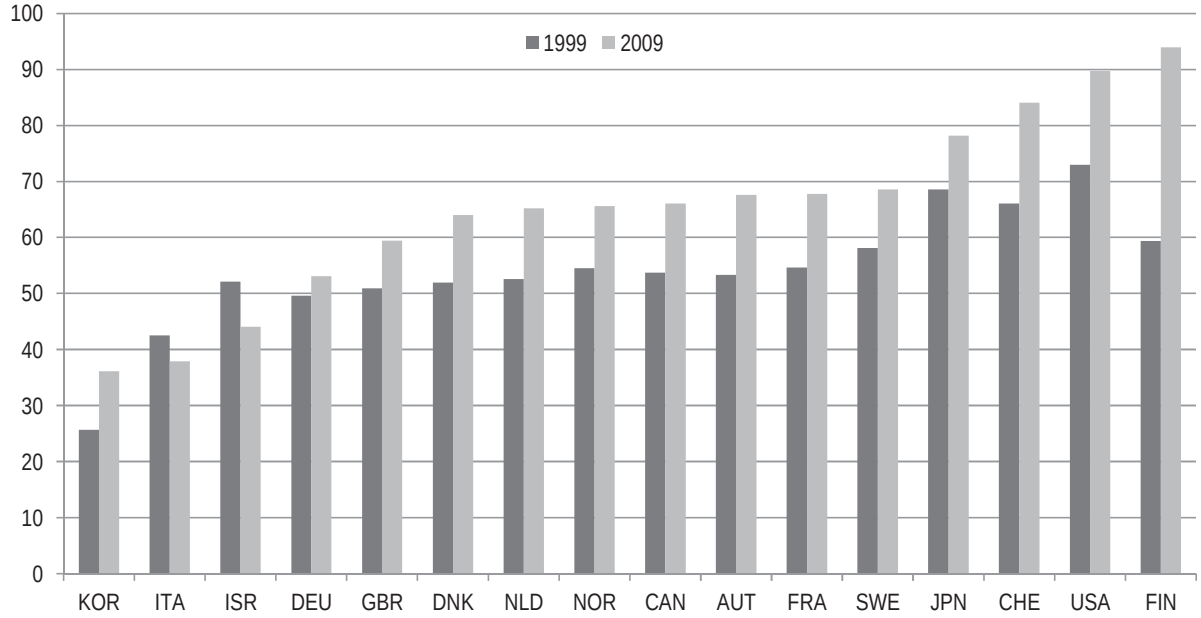


Note: Labour productivity and income levels are calculated using GDP at current prices and converted to US dollars using 2009 purchasing power parities. Labour utilisation is measured as total hours worked per capita. Labour productivity and labour utilisation level estimates for Israel, Slovenia and the Russian Federation are based on hours worked for 2008. The euro area includes Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, the Slovak Republic, Slovenia and Spain. France includes overseas departments.

Source: OECD Productivity Database, June 2012, *www.oecd.org/statistics/productivity*.

Figure 1.3. Productivity levels in manufacturing

Value added per worker in constant prices, EUR thousands



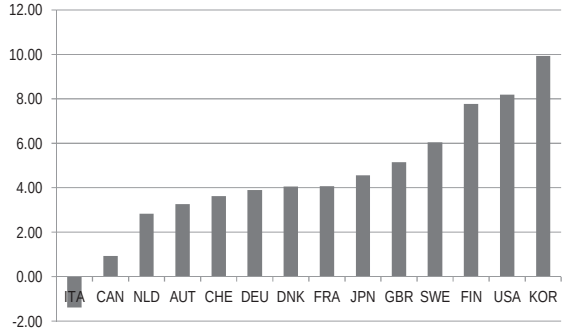
Note: 2000 for the Israel, 2006 for Canada, 2008 for Germany, Israel, Japan, United Kingdom and United States.

Source: OECD STAN Database for Structural Analysis.

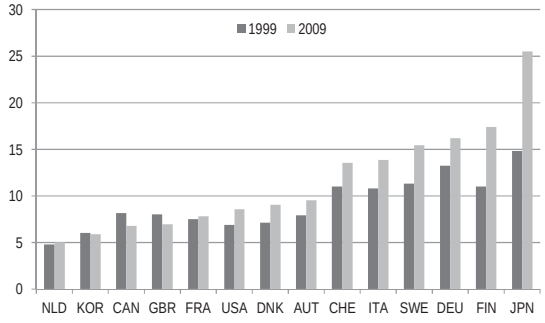
Figure 1.4. Productivity in high-technology sectors[1]

Percentages

A. Productivity growth 1999-2009, annual rate



B. Share of sector in total value added[2]



Notes: 1. Value added in constant prices divided by total employment. Includes medium-high technology manufactures. No productivity data available for Israel and Norway, no data on shares for Israel and Italy.

2. Excluding real estate activities.

Source: OECD STAN Database for Structural Analysis.

The continued gap in Sweden's GDP per capita *vis-à-vis* the United States is attributable to lagging labour productivity as measured by GDP per hour worked (Figure 1.2). Swedish levels are similar to those of Denmark, Switzerland and Austria (only Belgium, France and Germany record a smaller productivity gap, and only Norway and Luxembourg exceed US levels). Sweden makes up for a small part of its lag in labour productivity through a relatively favourable level of labour utilisation

One of Sweden's strengths is a high level of productivity in manufacturing (as measured by value added per worker), which is similar to that of France and Austria, but lags behind Finland, the United States, Switzerland and Japan (Figure 1.3). However, in the last decade Sweden has lost some ground in terms of manufacturing productivity *vis-à-vis* other countries, including Finland. Sweden has a strong combined high- and medium-high technology sector as indicated by its share in total value added. Among comparator countries, only Korea, Finland and Germany had higher shares in 2009. Sweden's share was 11% in 1999 but reached 15% by 2009, indicating structural change towards high-technology industries (Panel B of Figure 1.4). At the same time, the borderline between manufacturing and services has become increasingly blurred and major enterprises previously classified in manufacturing are today part of the services sector. Annual productivity growth in the combined high- and medium-high technology sector was 6% a year between 1999 and 2009 (Panel A of Figure 1.4). Finland, Korea and the United States recorded even higher productivity growth in this sector.

While there may be some scope for increasing labour utilisation – which is already comparatively high – continued improvements in labour productivity are critical for sustained growth. For Sweden, as a highly developed, high-income country which is at or at least close to the world technological frontier, multi-factor productivity (MFP) growth, which is largely driven by innovation, will have to play an important role in increasing labour productivity, per capita income and social welfare in a sustainable way.

A growth accounting study for the Swedish business sector, conducted by the National Institute of Economic Research, provides evidence of the importance of MFP for labour productivity growth and for growth in value added (NIER, 2008a). According to this study, labour productivity in the Swedish business sector increased on average by 3.3% a year during 1997–2005. Multi-factor productivity growth was identified as the main driver, contributing 2.0 percentage points a year. Capital deepening contributed an average 1.0 percentage point a year, and quality adjustment of hours worked contributed an average 0.3 percentage point, mostly owing to an increase in the proportion of employees with higher educational attainment. The NIER study found that half of the contribution from higher MFP was due to MFP growth in the ICT industry, which accounted for only about 8% of value added in the business sector. The ICT industry clearly played a critical role in boosting aggregate productivity growth.

Rapid productivity improvements will be necessary to ensure that Swedish enterprises maintain their international competitiveness in an increasingly globalised economy. Sweden's future prosperity therefore depends on a continued flow of innovations. In advanced economies, sustaining a high rate of innovation requires rapid absorption and adaptation of state-of-the-art knowledge and organisational practices from abroad and a continuous flow of innovations from domestic sources which interact with the international environment. Sweden is well positioned on both accounts. First, it has the institutional features (including a high degree of openness) and a high level of the skills needed to absorb knowledge. Second, it is among the world leaders in terms of investment in research and development (R&D), with research-intensive business

enterprises and a strong university research sector. However, high levels of investment in R&D and innovation need to be supported by a well-functioning innovation system to achieve high returns on these investments.

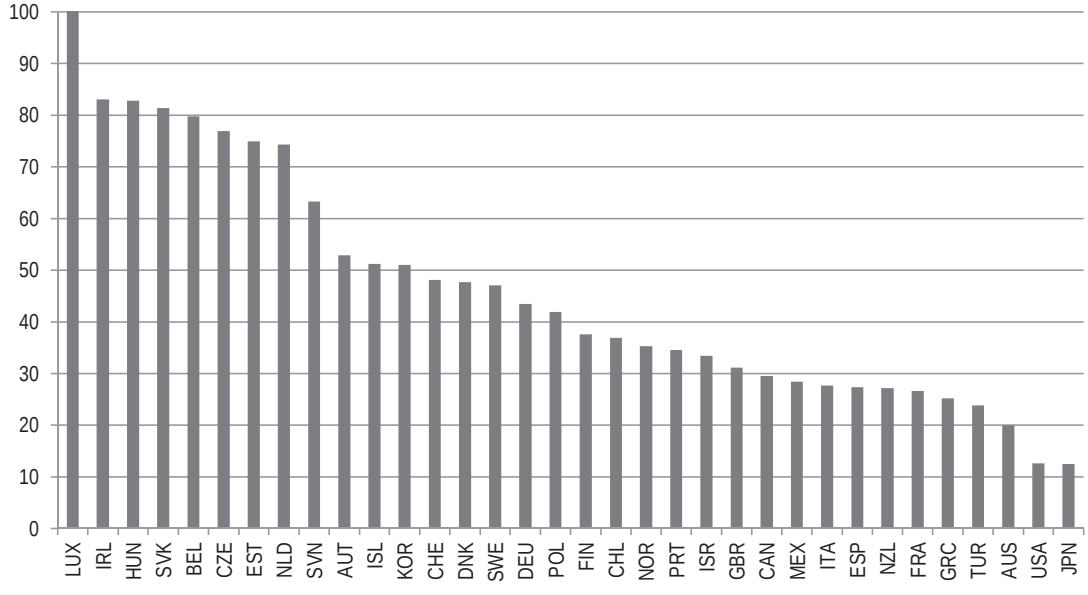
1.2. Globalisation and structural change

1.2.1. International openness: Trade and foreign direct investment

In a small open economy, foreign trade and cross-border direct investment flows are of critical importance for economic growth and development (Keller, 2004). In fact, openness – including to international trade – has been an important factor in Sweden's economic development. It enabled the country to overcome the constraints of a small home market and a peripheral geographical location (O'Rourke and Williamson, 1995). From the early days of Sweden's industrialisation, international trade and investment acted as channels of knowledge flows and were important for the modernisation of the economy and society. An orientation towards international markets – and an international mindset more generally – has been a pillar of Sweden's success until this day. Accordingly, Sweden has embraced globalisation enthusiastically, while some other, notably high-income, countries greeted the acceleration of this trend with reservations. Social protection has helped to hedge the risks associated with further globalisation, and active labour market policies combined with arrangements to share the benefits of productivity gains through wage and social policies have helped workers to accept technological and organisational change. These have been key ingredients of successful innovation and critical for maintaining competitiveness in international markets. Framework conditions such as well-functioning product markets, low barriers to entrepreneurship, and enhanced competition, including in key service sectors, which are discussed below, also play an important role in fostering innovation and economic performance.

Figure 1.5. Trade openness, 2010

Average of total exports and imports of goods and services as a percentage of GDP



Source: OECD Factbook 2011-2012 (OECD, 2012b). 2009 instead of 2010 for Australia, Canada, Ireland, Israel, Japan, Mexico, New Zealand and the United States.

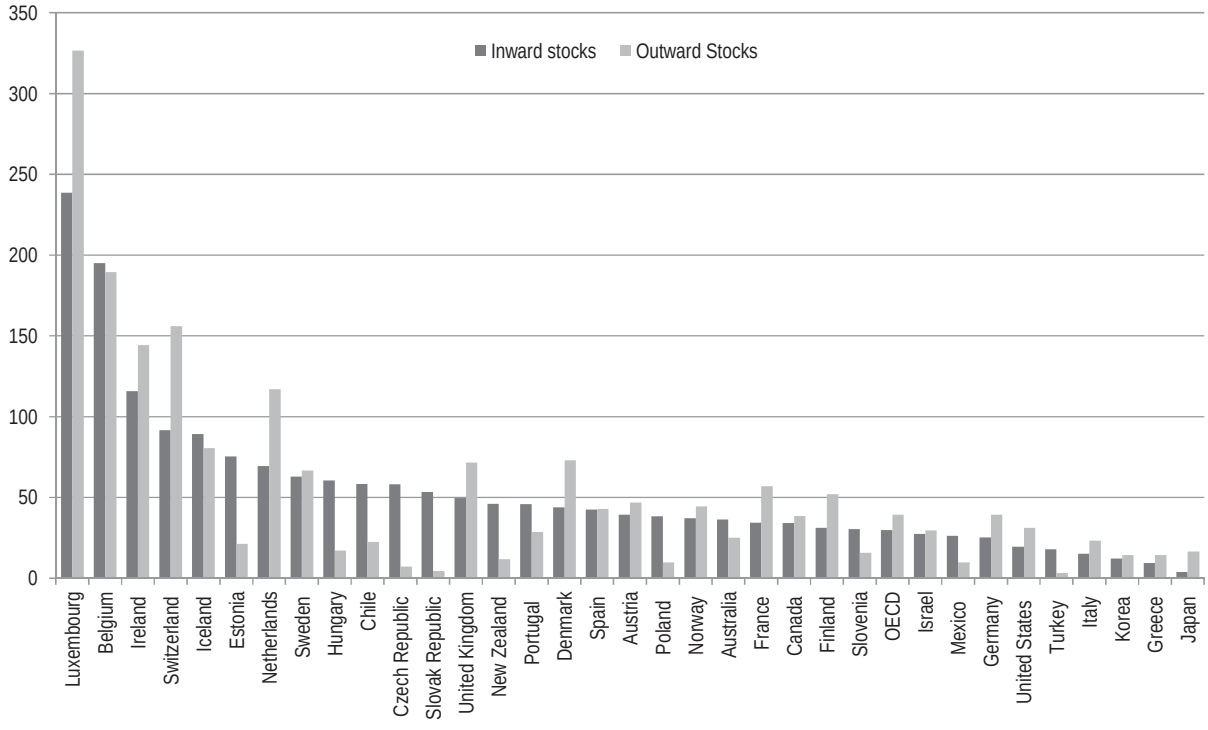
In 2010, exports plus imports were 47% of GDP (Figure 1.5). On this measure, Sweden is in a position similar to other small open economies in Europe such as Austria, Switzerland and neighbouring Denmark.

Foreign direct investment (FDI) can affect a country's innovation performance both directly and indirectly. It can boost host countries' productivity performance because firms receiving FDI often achieve efficiency gains through the transfer of technology, better organisational and management practices, human resources, or better integration in supply chains and international markets. In addition, "knowledge spillovers" may lead to efficiency improvements in the wider population of domestic firms. These improvements may occur in the same sector, in upstream or downstream firms (suppliers or customers), or in regional innovation networks involving foreign-controlled firms. FDI can also stimulate innovation indirectly, *e.g.* via increased competition.

In Sweden a particular aspect of FDI and globalisation has been in the foreground in public debates on R&D and innovation. Sweden has been the home of large, research-intensive and innovative multinational enterprises (MNEs), and has thus had the character of a "headquarters economy" which tends to concentrate some important functions, such as R&D. In the past two decades, mergers and acquisitions have led to important changes in industrial ownership and the ensuing restructuring has affected R&D activity performed in Sweden. In parallel, the globalisation of R&D and innovation has also profoundly changed how Swedish-owned enterprises organise their R&D effort.

Figure 1.6. FDI stocks, 2011 or latest available year

As a percentage of GDP



Source: OECD Investment statistics.

Today, Sweden's comparatively high levels of inward and outward FDI stocks surpass those of its Nordic neighbours, Finland, Norway and Denmark (in Denmark only for inward stocks) but fall short of those of European comparators such as Switzerland and the Netherlands (Figure 1.6). In 2011 Sweden's inward FDI stocks were 63% – and outward stocks 67% – of GDP, well above the OECD averages of 30% and 39% respectively. Large Swedish MNEs are linked to the world's knowledge centres and innovation networks (see Chapter 3 for a more detailed discussion). Outward FDI plays an important role in gaining access to cutting-edge information and technology as well as human resources and research infrastructure.

1.2.2. Structural change in production and international trade

Sweden's business sector accounts for most of aggregate value added (75% in 2008, up from 69% in 1998). Manufacturing accounted for 26% of total value added, a comparatively high share for a high-income economy, much of it for high- and medium-high-technology manufactures. The manufacturing sector also recorded high and fast-growing levels of value added per worker (5.6% a year over 1998-2008). The much smaller agriculture and post and telecommunications sectors had even higher productivity growth. High-technology manufacturing increased its share in total output during the period through strong productivity growth (8.1% a year): the share of low-technology manufacturing decreased and productivity growth was much slower (2.5% a year). The share of the construction industry in total value added has decreased slightly, with negative growth of value added per worker (-1.8% a year). Utilities also recorded a decrease in both the share of total value added and productivity (-0.8% a year). The share of wholesale and retail trade in total value added grew from 1998 to 2008 from 13.1% to 14.8% and that of post and telecommunications increased from 2.1% to 3.2%.

Table 1.1. Value added and productivity by sector[1]

	Value added per worker (% growth)[2]	Share in total value added (%)[3]		Share in total output (%)[3]		Value added per worker (SEK 1 000)	
	1998-2008	1998	2008	1998	2008	1998	2008
Business sector[4]	2.7	68.9	74.8	76.7	80.2	471.1	613.2
Agriculture	6.1	2.4	2.5	2	1.7	312.0	561.5
Manufacturing	5.6	22.8	26.3	34.6	35.2	466.2	801.0
High and medium-high technology manufactures	8.1	10.4	15.5	16.2	19.6	482.2	1 052.0
Low technology manufactures	2.5	8.0	6.3	11.1	9.0	461.6	589.2
Construction	-1.8	5	4.4	5.4	5.2	398.7	332.2
Utilities	-0.8	2.8	2.1	2.2	1.8	1 475.2	1 362.7
Post and telecommunications	8.6	2.2	3.2	2.2	3.2	496.9	1 128.6
Transport and storage	0.4	6.8	5.6	8.6	7.8	525.6	547.1
Wholesale and retail trade	3.2	13.1	14.8	10.3	11.6	344.3	473.6

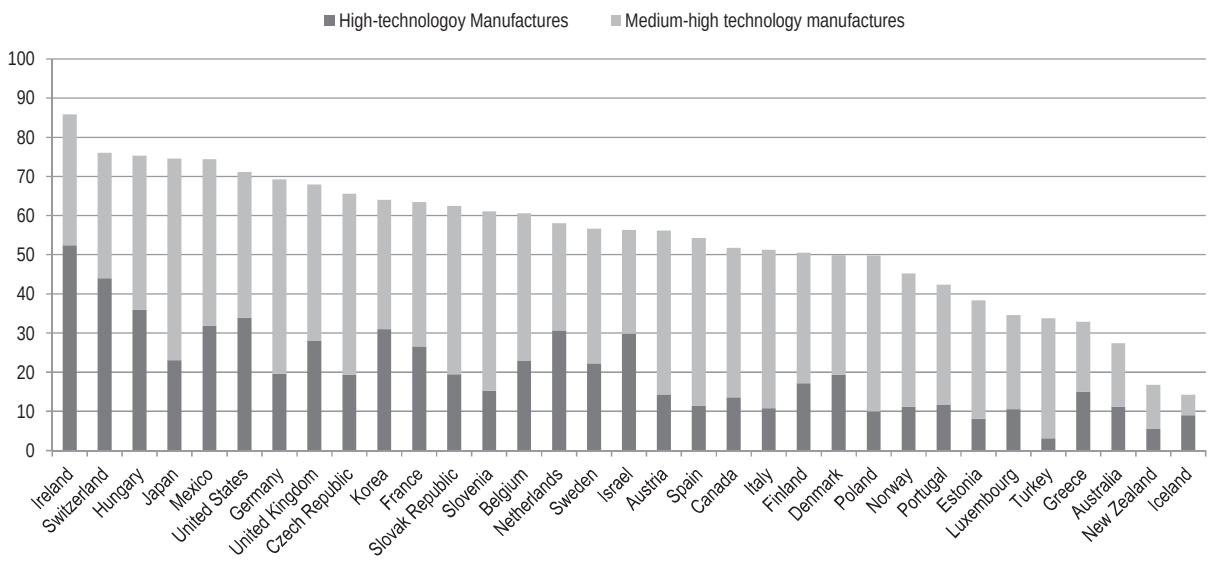
1. Using value added and gross output in constant prices, and total employment.
2. Annual rate.
3. Excluding real estate activities.
4. Non-agriculture business sector services excluding real estate activities.

Source: OECD STAN Database for Structural Analysis.

Sweden's total manufacturing exports grew less rapidly than those of many other OECD countries over 2000-11, despite expansion of 8% a year. Sweden's combined share of high-technology and medium-high-technology manufacturing exports in total manufacturing exports was around the OECD average (Figure 1.7). High-technology exports represent 22% of Sweden's manufacturing exports. By comparison, they accounted for 44% in Switzerland and 19% in Denmark. While Sweden performs relatively well in this category, it is less successful in the medium-high-technology segment, at 34%. While this is higher than in other Nordic countries, many OECD members have much higher levels. Japan leads with 52% of manufacturing exports in this category. Sweden's high-technology exports grew by an average annual 4% over 2000-11 (Figure 1.8) compared to 8% for Norway and Denmark, while Finland's exports contracted by 2%. Although Sweden's high-technology exports were hard hit by the crisis and contracted by 15% in 2009, growth rebounded rapidly.

Sweden performed somewhat better in terms of growth of medium–high-technology exports, with an average growth rate of 9% over 2000-11, in spite of a contraction of 33% in 2009. Recovery was quick, however, and these exports are now at levels only slightly below the peak of 2008. These growth rates are in the same range as those of comparator countries, notably Denmark and Finland. Table 1.2 provides a snapshot of Sweden's most important export products. Sweden's most important export is boilers, machinery, nuclear reactors etc. This category accounts for 14.45% of Sweden's exports and is predominantly comprised of automatic data processing machines and machinery. The Electrical sector is also very prominent, particularly the electric apparatus for line telephony. Sweden's Paper and paperboard sector is competitive on the world scale, comprising 6.43% of world exports. Most important exports have experienced some growth during the period 2006 to 2010, with the main exception of vehicles, that suffered a loss of 8%.

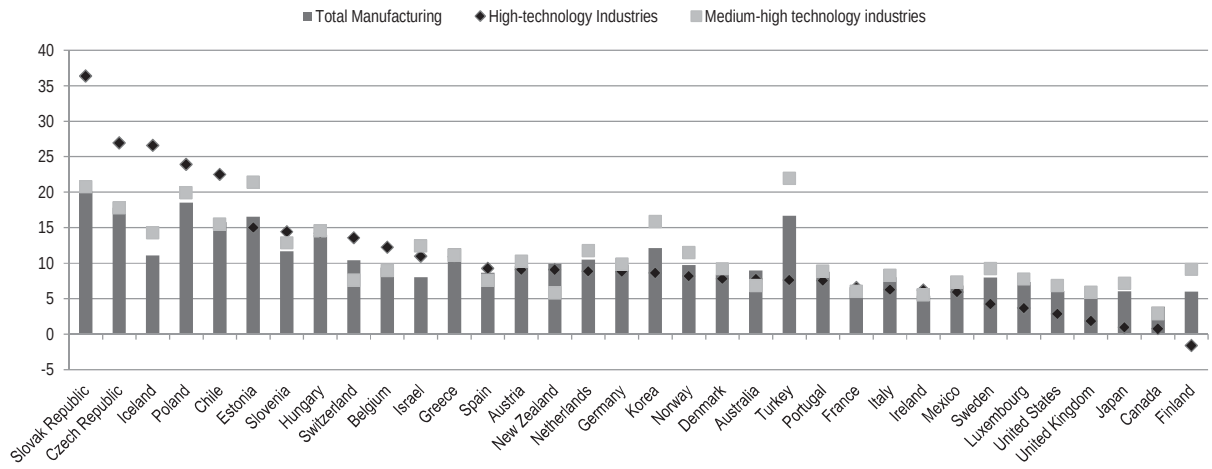
Figure 1.7. Shares of high- and medium-high-technology manufacturing exports, 2010 (or latest available year)



Source: OECD stat.

Figure 1.8. Growth of high- and medium-high-technology exports, 2000-2011

Average annual growth rate, nominal



Source: OECD STAN Database.

Table 1.2. Sweden's 10 most important export items, 2010

Harmonised System (HS), 2-digit level

	Exports (in USD millions)	Exports as a share of total exports (%)	Exports as a share of world exports (%)	Growth of exports 2006-10 (% per year)
84 Boilers, machinery; nuclear reactors, etc.	22 846.0	14.45	1.25	2
85 Electrical, electronic equipment	21 524.5	13.62	1.06	2
87 Vehicles other than railway, tramway	13 400.2	8.48	1.25	-8
27 Mineral fuels, oils, distillation products, etc	11 055.7	6.99	0.48	8
48 Paper & paperboard, articles of pulp, paper and board	10 820.5	6.85	6.43	2
99 Commodities not elsewhere specified	9 052.8	5.73	1.14	2
30 Pharmaceutical products	8 543.5	5.4	2	0
72 Iron and steel	6 925.1	4.38	1.8	0
39 Plastics and articles thereof	5 263.3	3.33	1.09	4
90 Optical, photo, technical, medical, etc., apparatus	4 924.3	3.12	1.01	5

Source: Trade Competitiveness Map, International Trade Centre.

A widely used means of examining differences in export specialisation focuses on comparative advantage. In practice a country's comparative advantage in a particular commodity or industry is measured by an index using observed trade patterns, known as revealed comparative advantage (RCA).[2] Table 1.3 shows the number of categories of goods (out of a total of 68) with an RCA index value of one or more for each of the countries in the reference group. Sweden is specialised (has a comparative advantage) in 27 categories, exceeded only by Denmark, with 29. Almost all of Sweden's RCA values

are between 1 and 2, which means that these sectors (at this level of aggregation) are only slightly specialised. Three Swedish sectors have RCA values above four: pulp, paper and wood. Denmark and Finland have a higher degree of specialisation with a larger share of RCA values above 2.

Table 1.3. Number of goods where RCA is above 1 by RCA brackets, 2009

SITC, 2-digit level

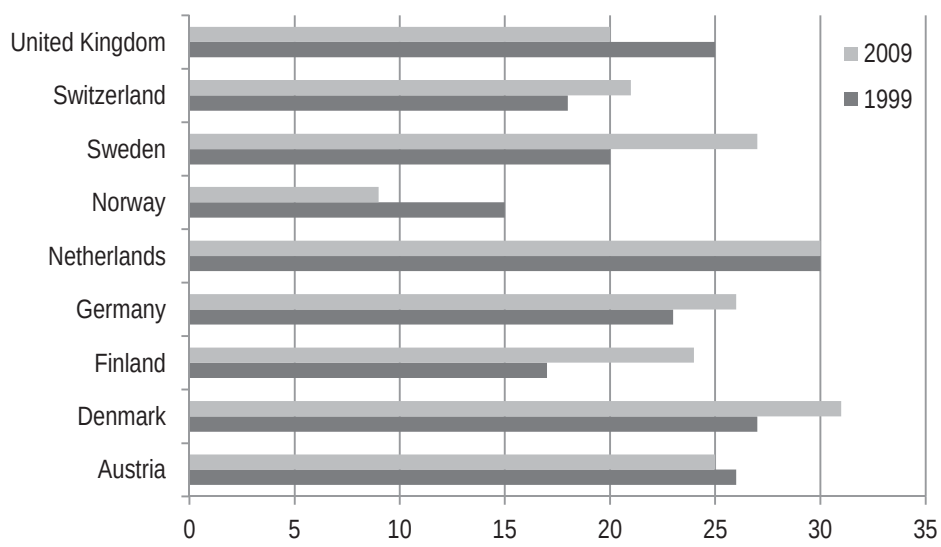
	RCA>1	1<RCA<=2	2<RCA<=3	3<RCA<=4	4<RCA
Austria	25	15	6	2	2
Denmark	31	16	6	1	8
Finland	24	14	4	0	6
Germany	26	23	3	0	0
Netherlands	30	18	6	5	1
Norway	9	2	2	2	3
Sweden	27	23	1	0	3
Switzerland	21	12	4	2	3
United Kingdom	20	15	3	1	1

Source: OECD stats Globalisation Micro indicators on trade.

Among the group of comparator countries, Sweden and Finland had the largest increase in the number of specialised sectors between 1995 and 2009 (Figure 1.9). This shows that in a period of rapid globalisation and technological change, Sweden succeeded in broadening its range of sectors of specialisation.

Figure 1.9. Number of goods with an RCA above 1, 1999 and 2009

SITC, 2-digit level



Source: OECD stats Globalisation Micro indicators on trade.

These results indicate that Sweden has been flexible and successful in a period of wide-ranging global changes. However, despite these successes, there are also indications that Sweden has lost some ground in core sectors of the Swedish economy such as telecommunications, motor vehicles and the manufacture of metals (see Chapter 3).

An important trend in the Swedish economy with implications for innovation and innovation-related policies is the increasing importance of services (Box 1.1). The weight of the Swedish services sector in the economy has been growing over time. Financial services have increased the most and have almost doubled in size. Until the beginning of the 1990s, expansion of the services sector largely concerned public-sector services. Since the mid-1990s private-sector services have dominated (Lagerqvist, 2012). Today private-sector services account for 45% of employment and in all, three out of four Swedes work in the services sector. Knowledge-intensive business services (KIBS) is a large growth engine, as almost every other Swede works in a KIBS firm (Lagerqvist, 2012). Service exports have also become increasingly important and account for one-third of total exports.

Box 1.1. The increasing importance of services

A Swedish Ministry of Enterprise report published by Growth Analysis highlights the increasing importance of services in the Swedish economy and discusses the consequences for economic development. The main observations are summarised below:

- Employment in the services sector has increased over the past 15 years and has declined in manufacturing industry.
- From 1994 to 2009, the services sector made the largest contribution to productivity development. Producer services as well as wholesale and retail trade account for the largest contribution to productivity growth.
- The knowledge-intensive business services sector has consistently increased its share in employment. Its level of productivity and growth is above average when compared to the total economy. The KIBS contribution to labour productivity growth is considerable. In the producer services sector it contributes the lion's share of the increase in labour productivity growth.
- Service exports have grown faster than commodity exports over the past 15 years. Service activities in the production of goods are significant and the service content of export goods increases in line with a country's rising income levels. Productivity is highest in companies that export both goods and services.
- Service innovations are different from innovations in the manufacturing industry, but as many service innovations can now be coded, packaged and distributed by using information technology, services can be standardised and converted into products as in the manufacturing industry. This has considerable effects on productivity in the service sector.

Source: Growth Analysis (2010).

1.3. Framework conditions for innovation and entrepreneurship

1.3.1. The role of framework conditions for entrepreneurship

The macroeconomic framework, the general business environment, product and labour market regulations, the intensity of competition, business finance, the level and quality of entrepreneurship, the tax system and infrastructure all influence a country's innovation performance. Good framework conditions and a healthy business environment are key prerequisites for strong performance in innovation. There are several reasons for the importance of framework conditions for innovation performance:

- Innovation activity requires a medium- or long-term horizon and a sufficiently stable environment in which to carry it out. This is particularly important for R&D and more fundamental types of innovation activity.
- The regulatory framework is of crucial importance for the generation of new technologies and for the speed of their diffusion. Developments in the telecommunications sector in recent decades have demonstrated this, and Sweden has in this connection been among the world leaders.
- When framework conditions are of insufficient quality, they are likely to reduce the effectiveness of policies designed to foster innovation.

Favourable framework conditions facilitate innovation throughout the economy. However, OECD experience shows that "dedicated" policy measures are also needed to address specific market or systemic failures that hamper R&D and innovation. Empirical OECD work has found that both framework conditions and dedicated science, technology and innovation (STI) policies affect innovation performance, separately and in combination. This work has helped to identify the policies, institutions and framework factors that support innovation effectively (Jaumotte and Pain, 2005a, 2005b, 2005c and 2005d).

Overall, framework conditions for innovation and entrepreneurship in Sweden are supportive and have contributed to good economic performance and resilience in the aftermath of the global financial and economic crisis. They include macroeconomic stability, strong human capital, declining corporate tax rates and low regulatory barriers. One indication of the quality of Sweden's framework conditions is that, within Europe, the contribution of resource allocation to aggregate productivity growth was relatively high during the 2000s, and much greater than in France and Italy (Altomonte, 2010). In other words, the economy has had the capacity to reallocate resources efficiently from lower to higher productivity uses.

This section considers broad features of entrepreneurial activity and key framework conditions in the areas of finance, infrastructure, taxation and product market competition. In many respects, Sweden has one of the best environments worldwide for operating a business. There is ready access to bank lending, and for some time Sweden has had one of the largest venture capital industries in the OECD area. Yet, both the level of activity and the number of private venture capital funds have contracted sharply in recent years. Early-stage equity finance is supplied largely through a combination of relatively limited business angel activity and public support. The government has taken an active policy role in financing risk capital. However, certain operations of the publicly supported organisations, and the relationships between these organisations, may require attention. The government has in fact stated its intention to restructure the publicly owned venture capital institutions.

In terms of infrastructure, household and business access to broadband Internet exceeds the OECD or EU averages, and standard mobile broadband subscriptions, at 52 per 100 persons, is considerably higher than in most other OECD economies. In recent years corporate income tax has been lowered and now, at 26.3%, the combined corporate income tax rate is in line with the OECD average. Sweden's product-market policy settings are also largely in line with OECD best practice. In addition to broadly conducive framework conditions, Sweden has undertaken a range of reforms to facilitate business, such as steps to curtail late payments to small firms.

1.3.2. Stylised features of entrepreneurship

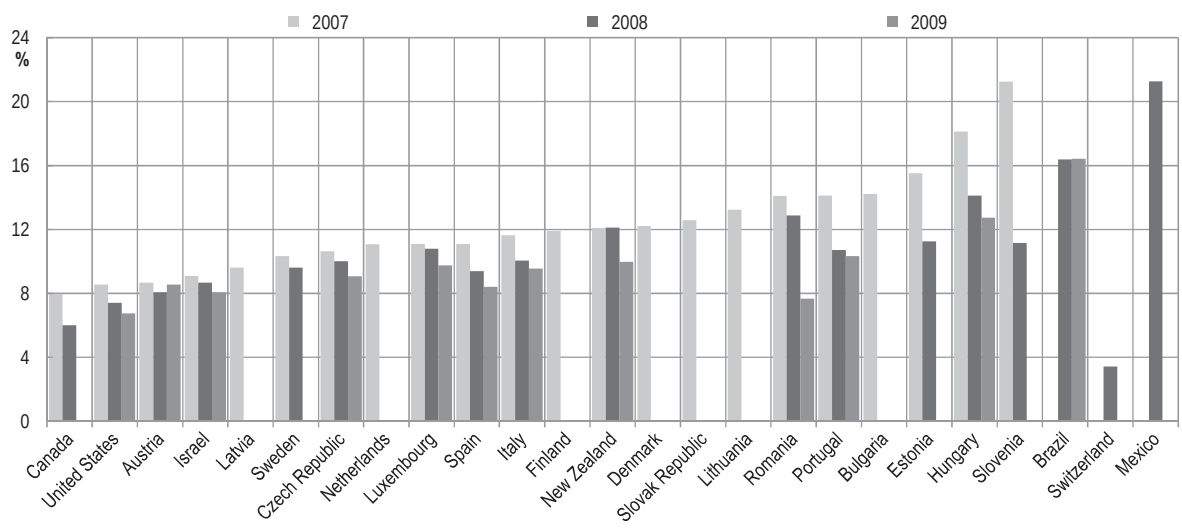
Firm turnover can be an important source of growth of multifactor productivity, which reflects the change in the efficiency of use of labour and capital inputs. The overall process of business entry, growth and exit is a critical source of structural change and innovation.

The global crisis has had a deleterious effect on start-up rates (OECD, 2012c). Between 2007 and 2009 enterprise birth rates fell in all countries for which data are available. Interpretation of data on firm births must take account of the fact that start-up may occur for reasons of need (lack of alternative opportunities) rather than opportunity. The data presented here therefore refer to employer enterprise births (*i.e.* an enterprise which recruited at least one employee in the year of birth). Figure 1.10 depicts employer enterprise birth rates across countries. Although the Swedish data do not extend to 2009, it is apparent that the birth rate is not particularly low, and is above that of recognised entrepreneurial economies such as the United States and Israel.

More than 66 000 enterprises were established in 2010, an increase from 2009 of 12% overall and of 15% in Stockholm.[3] In 2010, there were 11.1 new firms per 1 000 persons in the population aged 16-64, up from 10.0 in 2009. In 2010, 26% were started by persons under 30 years old and 50% by persons aged between 31 and 50 (increases of 18% and 9%, respectively).

Figure 1.10. Employer enterprise birth rate, total economy

Percentage of active enterprises with at least one employee



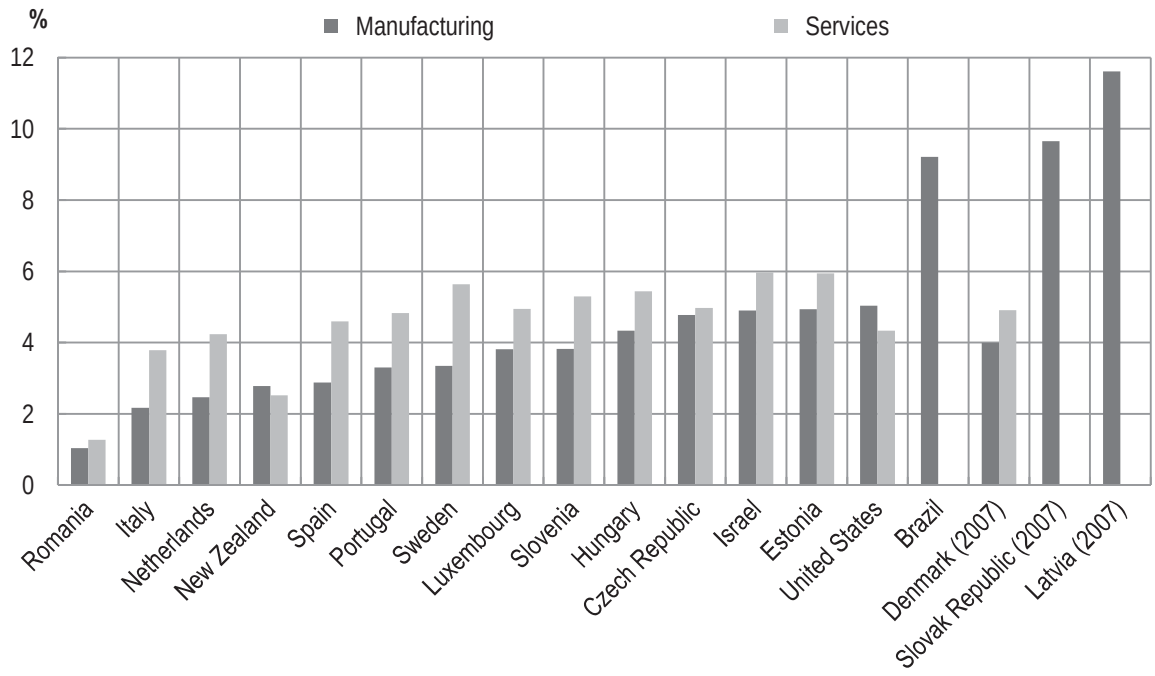
Source: OECD (2012c), *Entrepreneurship at a Glance*.

The presence of high-growth enterprises is another feature of entrepreneurial dynamism. In Figure 1.11, high-growth enterprises are those with average annualised growth in employees (or in turnover) exceeding 20% a year over a three-year period, and with ten or more employees at the beginning of the observation period. Measured by growth in employment, these enterprises are typically between 3.5% and 6% of total enterprises (the proportion with high growth in turnover is larger). In most countries,

high-growth firms (by employment) are more frequent in services. Sweden has one of the highest proportions of high-growth firms in the services sector, surpassed only by Israel and Estonia. In manufacturing, Sweden's relative position is somewhat weaker, but many countries with a larger share of high-growth firms are small former transition economies with somewhat idiosyncratic growth features.

Figure 1.11. High-growth enterprises as a share of all enterprises, 2008, or latest available year

Measured by growth in employment



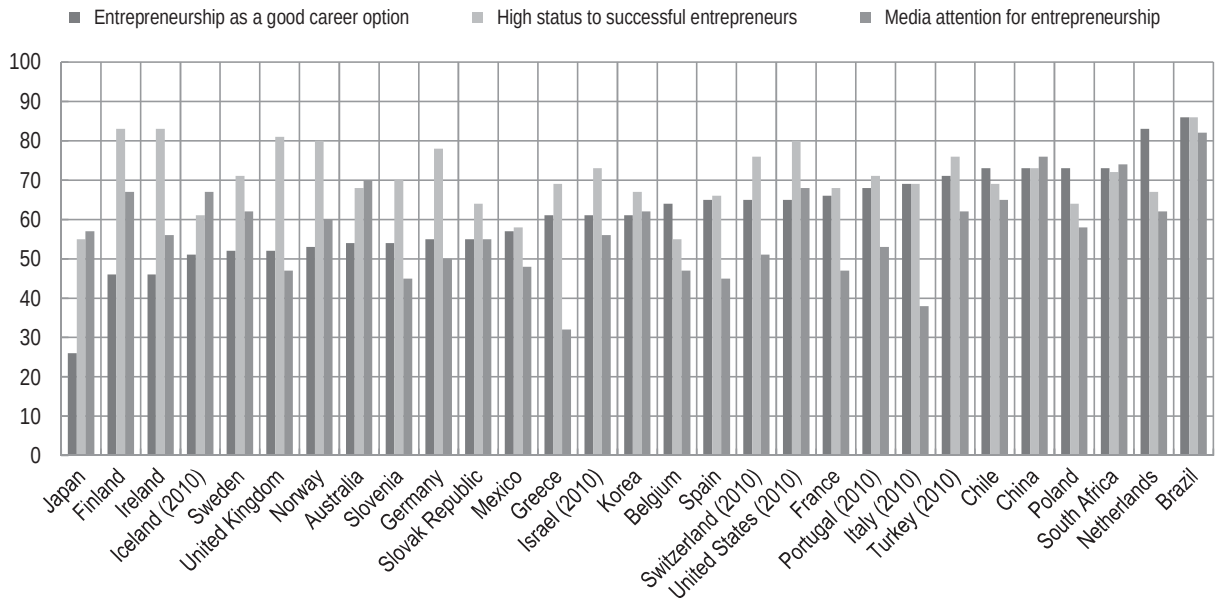
Source: OECD (2012c), *Entrepreneurship at a Glance*.

The OECD review team met with a number of entrepreneurs who felt that social attitudes in Sweden towards entrepreneurship are occasionally unsupportive. While the interplay between culture and entrepreneurial outcomes is not well understood, social attitudes are likely to play a role. Figure 1.12 shows certain elements of society's views of the entrepreneur and entrepreneurship.

While Sweden does not rank very high in terms of viewing entrepreneurship as a desirable career option, the combined results do not suggest significantly negative attitudes towards entrepreneurship. In fact, the perception of social prestige attached to successful entrepreneurs and of the frequency of media coverage of entrepreneurship rank slightly above average. Data gathered as part of Sweden's 2008 Entrepreneurship Barometer suggested that the share of people aged 18-30 willing to become entrepreneurs had risen from 71% in 2003 to 74% in 2008.[4]

Figure 1.12. Attitudes to entrepreneurship, 2011 or latest available year

Among the population aged 18-64



Source: OECD (2012c), *Entrepreneurship at a Glance*, based on data from the Global Entrepreneurship Monitor (GEM) project.

1.3.3. Administrative burdens, regulation and entrepreneurship

Establishing a company in Sweden is straightforward and regulatory barriers are low. Rules also appear to be clear. According to the World Bank's *Doing Business*, starting a business in Sweden requires just three procedures, takes 15 days, costs 0.6% of average income per capita and requires paid-in minimum capital of 14.0% of average income per capita. To create a sole proprietorship (*enskild firma*) one needs to fill in an online form and pay SEK 1 200 (around EUR 120). Approximately two weeks later the company can send its first invoices. Table 1.4 shows data on the costs and procedures required to start a business in Sweden and comparator countries. Only one country requires fewer procedures than Sweden, and in only two is the cost of business creation lower.

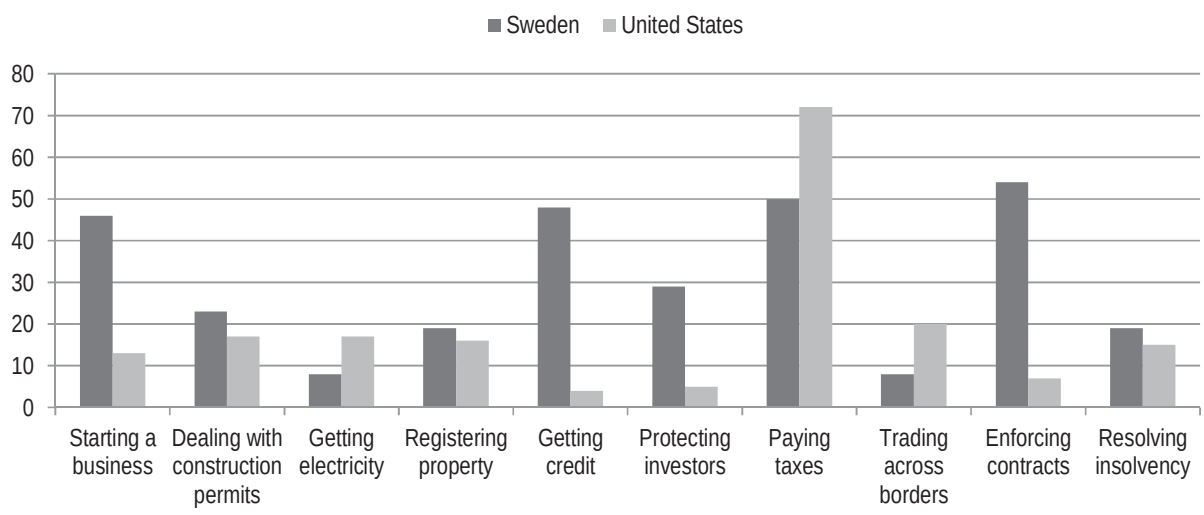
Figure 1.13 summarises information on the ten dimensions of creating and running a business captured in the World Bank's *Doing Business 2012* for Sweden and the United States (World Bank, 2012).[5] Each of the vertical bars shows the ranking – among the 183 economies covered by the study – of Sweden and the United States on the dimension in question (each dimension is composed of a number of indicators). A low numerical ranking on the ease of doing business index means that the regulatory and institutional environment is more conducive to the starting and operation of a firm. For example, on the dimension "Ease of starting a business", Sweden ranked 46 among the economies in the study. The World Bank data suggest that on many dimensions Sweden provides one of the best environments globally as regards the operation of a business. Sweden ranks slightly less well on the dimension "getting credit" (48 compared to the OECD average of 41), on "paying taxes" (50 compared to the OECD average of 62), and on "enforcing contracts" (54 compared to the OECD average of 37).[6]

Table 1.4. Ease of starting a business, Sweden and comparator countries, 2012

	Number of procedures	Time required (days)	Cost (% income per capita)	Paid-in minimum capital (% of income per capita)
Sweden	3	15	0.6	14.0
Austria	8	28	5.2	52.0
Canada	1	5	0.4	0.0
Denmark	4	6	0.0	25.0
Finland	3	14	1.0	7.3
France	5	7	0.9	0.0
Germany	9	15	4.6	0.0
Israel	5	34	4.4	0.0
Italy	6	6	18.2	9.9
Japan	8	23	7.5	0.0
Korea	5	7	14.6	0.0
Netherlands	6	8	5.5	50.4
Norway	5	7	1.8	19.4
Switzerland	6	18	2.1	26.9
United Kingdom	6	13	0.7	0.0
United States	6	6	1.4	0.0
OECD	5	12	4.7	14.1

Source: World Bank, Doing Business Database.

Figure 1.13. Ease of doing business – Sweden and the United States in global rankings



Source: World Bank, *Doing Business database*.

1.3.4. Competition

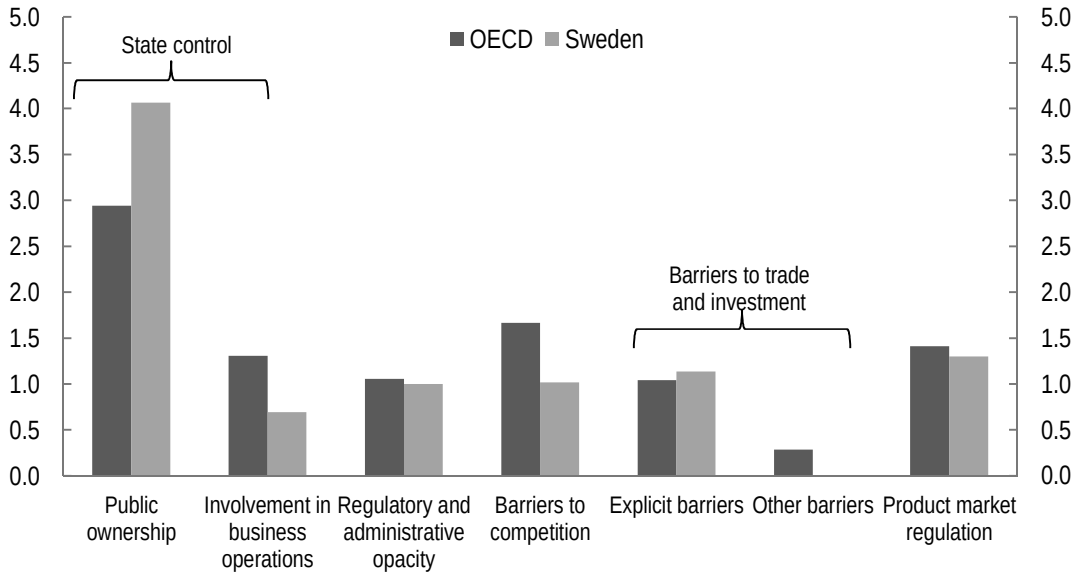
There is general agreement that competition is central to innovation, even if debate continues regarding the circumstances under which it has the greatest effect.[7] Research shows that competitive product markets force companies to increase labour productivity and MFP. The most direct effect of competition policy is on organisational change in firms; it affects research and invention rather modestly but has a greater effect on the commercialisation of new science and technology and on efforts to diffuse innovations throughout the economy (Shapiro, 2002). Also, when intellectual property rights (IPR) are well enforced, entrepreneurs may be more ready to assume the risks of innovation. OECD research shows that, for a given level of IPR protection, regulatory barriers to entry in product and labour markets undermine long-run productivity and that the burden of regulation rises the further a country is from the technology frontier. Reducing anti-competitive regulation induces businesses to increase spending on R&D (Jaumotte and Pain, 2005d).

In these areas, Sweden's product market policy settings are largely in line with OECD best practice. Figure 1.14 shows Sweden's standing relative to the OECD average on a range of indicators of product market regulation. The OECD PMR indicators (see Box 1.2) are a comprehensive, internationally comparable set of measures indicating the degree to which policies promote or inhibit competition in areas of product markets where competition is viable. The index scale of 0-6 runs from least to most restrictive. State control is the indicator on which Sweden scores significantly below the OECD average. It measures the share of sectors in which the public sector controls at least one firm. However, the use of price controls and command and control regulation is comparatively limited.

The barriers to competition considered here are the share of sectors with explicit legal limitations on the number of actors, the scope of exemptions to competition law for public enterprises, and barriers to entry in network sectors (such as electricity and transport) and in retail and professional services. Overall, Sweden performs above the OECD norm.

Openness to trade and FDI flows (both inward and outward) drives innovation: it reinforces competition and facilitates knowledge flows from abroad. As Figure 1.14 shows, barriers to trade and investment in Sweden are on a par with the OECD average. A further, and indirect, indicator of the regulatory burden on trade (and infrastructure endowment) is the propensity of small firms to export. Small firms are generally more sensitive to regulatory burden than larger firms. Figure 1.15 shows that in Sweden, the percentage of enterprises that export in each size class of firm is higher than in other OECD countries for which data are available (as of 2008).

Figure 1.14. Product market regulation indicators, Sweden and the OECD, 2010



Note: Details on indicator construction can be found at *www.oecd.org/dataoecd/32/9/42131723.pdf*.

Source: OECD.stat - Market regulation database.

Box 1.2. The OECD product market indicators

A number of diagnostic tools have been developed to measure product market regulation and benchmark regulatory frameworks. One of these tools is the OECD product market indicators system. The OECD's PMR indicators assess the extent to which the regulatory environment promotes or inhibits competition in markets in which technology and market conditions make competition viable. These indicators have been used extensively over the last decade to benchmark regulatory frameworks in OECD and other countries and have proven useful in encouraging countries to implement structural reforms that enhance economic performance.

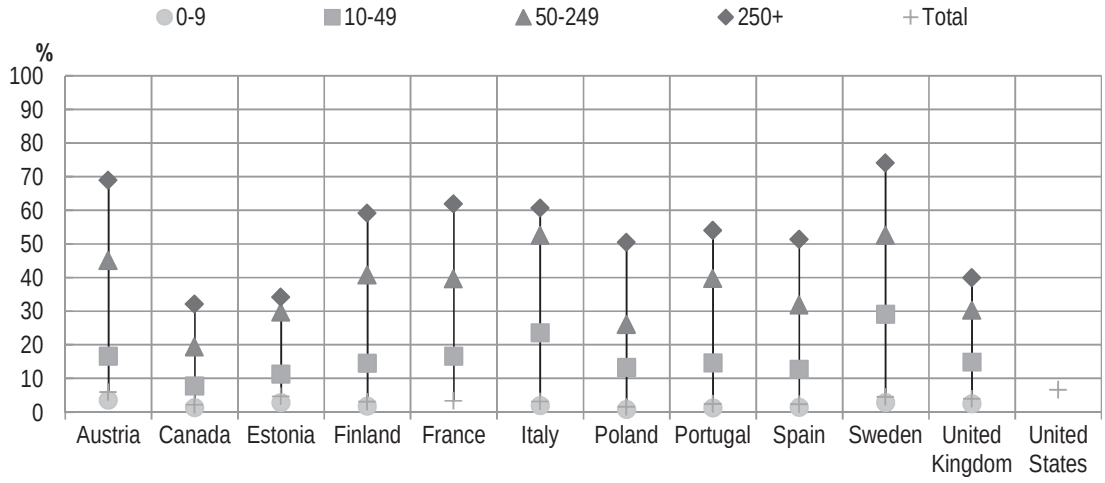
The PMR indicator system summarises a large number of formal rules and regulations that have a bearing on competition. The regulatory data cover most of the important aspects of general regulatory practice as well as a range of features of industry-specific regulatory policy, particularly in the network sectors. This regulatory information feeds into 18 low-level indicators that form the base of the PMR indicator system. These low-level indicators are then aggregated. At the top of the structure, the overall PMR indicator serves as a summary statistic on the general stance of product market regulation.

The PMR indicators have a number of characteristics that differentiate them from other indicators of the business environment. First, in principle, the low-level indicators only record "objective" information about rules and regulations, as opposed to "subjective" assessments of market participants as in indicators based on opinion surveys. This isolates the indicators from context-specific assessments and makes them comparable across time and countries. Second, the PMR indicators follow a bottom-up approach, in which indicator values can be related to specific underlying policies. One of the advantages of this system is that the values of higher-level indicators can be traced with an increasing degree of detail to the values of the more disaggregated indicators and, eventually, to specific data points in the regulation database. This is not possible with indicator systems based on opinion surveys, which can identify perceived areas of policy weakness, but are less able to relate these to specific policy settings.

Source: OECD (2009).

Figure 1.15. Export propensity by enterprise size class, 2008

Percentage of exporting enterprises in total enterprises in the corresponding size class

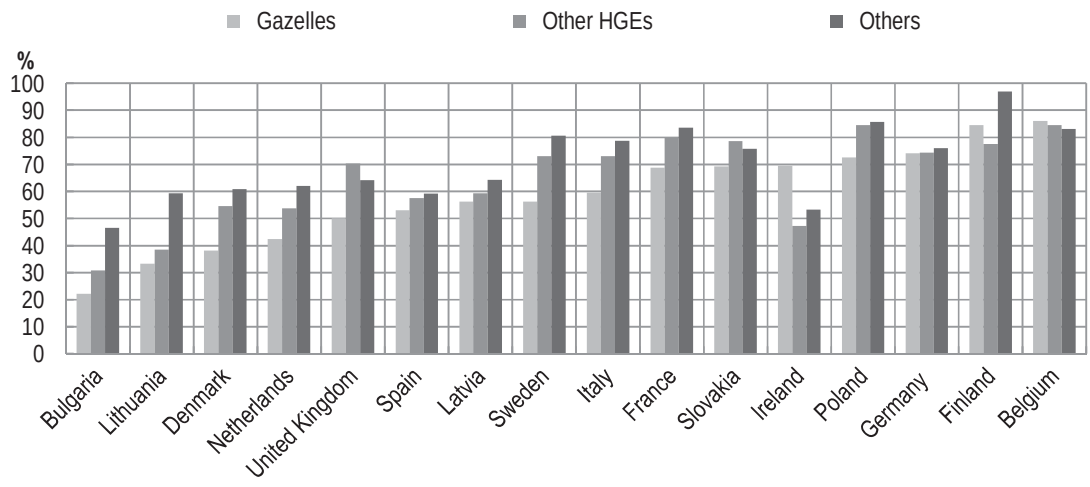


Source: OECD (2012c), *Entrepreneurship at a Glance*.

1.3.5. Finance and entrepreneurship

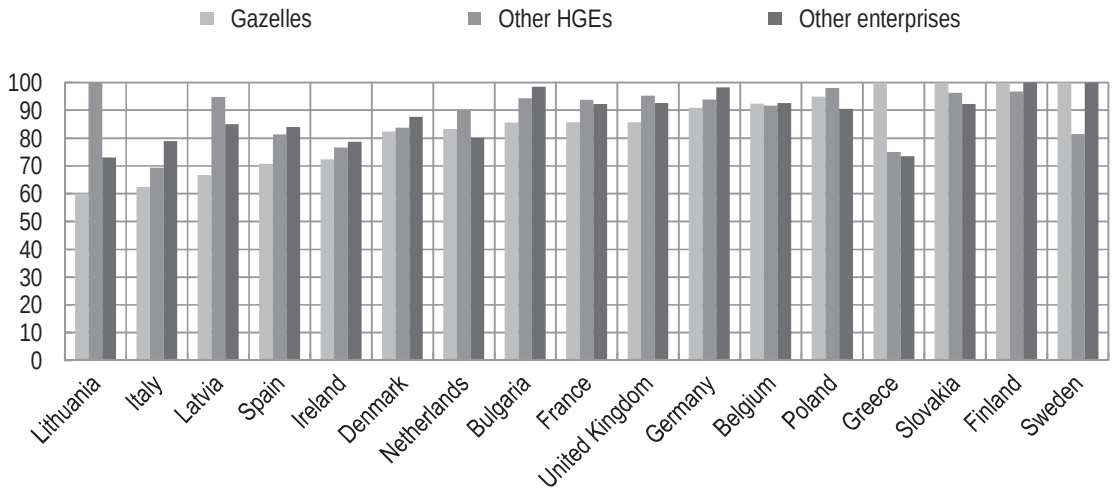
In Sweden most SMEs rely on the commercial banking sector for external finance. Internationally comparative data, from just before the global crisis, show ready access to bank lending in Sweden. Figure 1.16 provides information on approvals of SMEs' requests for loans. The data are from a 2010 survey of 20 European countries co-ordinated by Eurostat. Excluding gazelles and other high-growth enterprises, SMEs' success in seeking bank loans is only exceeded by four countries. Success in obtaining lease finance is even greater (Figure 1.17).[8]

Figure 1.16. Success in obtaining bank loans among SMEs, 2010 (%)



Source: OECD (2012c), *Entrepreneurship at a Glance*.

Figure 1.17. Success in obtaining leasing, 2010 (%)



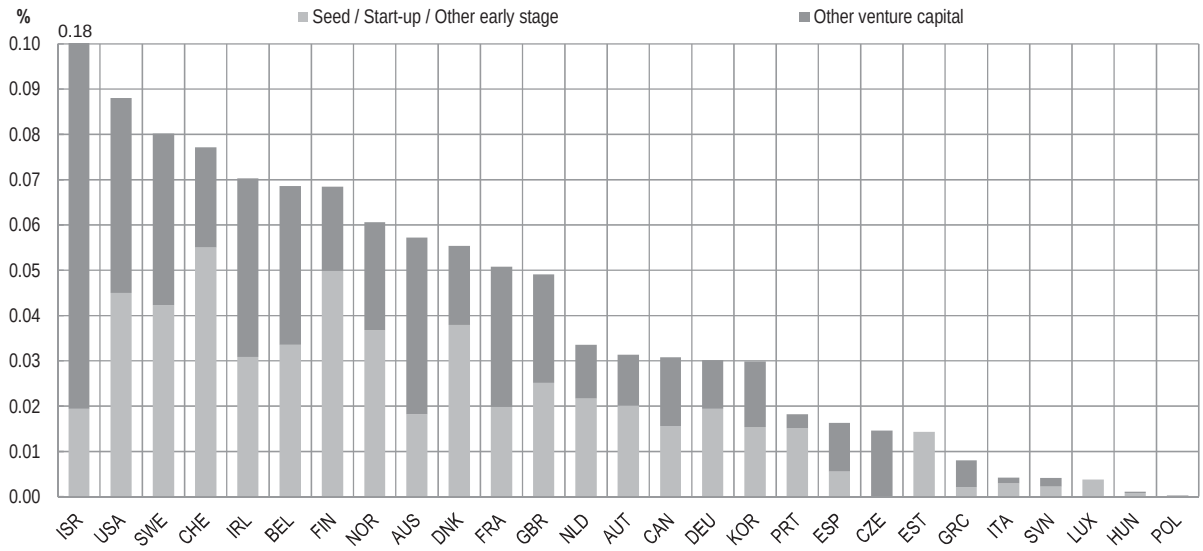
Source: OECD (2012c), *Entrepreneurship at a Glance*.

Venture capital

Comparative data to 2009 indicate that Sweden has one of the largest venture capital industries in the OECD area, measured as a share of GDP (Figure 1.18). Indeed, only Israel and the United States stand ahead of Sweden in this respect. However, in recent years the activity of private venture capital funds has contracted sharply, in terms of volume of funds invested and number of funds. The contraction is reported to have been particularly sharp following the start of the global financial crisis, in midst of an already downward trend.[9] National privately owned venture funds are reported to have fallen from 25 before the crisis to four (it is unclear however the extent to which these funds invest in early-stage deals). The sharpest contraction appears to have been in early-stage deals (Andersson, 2011). There appears to be too few venture capital players able to raise sufficient funding for certain types of deal (*e.g.* for work on new battery technology). Exit opportunities are reported to be limited. Through grants and other mechanisms, the funding available at the pre-seed and seed stages may be adequate. But for firms that survive and grow an equity gap in the range of SEK 5-10 million may be significant (Andersson, 2011).

Figure 1.18. Venture capital investment, 2009

(% of GDP)



Source: OECD (2011b), *Entrepreneurship at a Glance*, based on OECD Entrepreneurship Financing Database, June 2011.

Business angels

Business angels are private persons who invest in and provide business know-how to unlisted companies. In many countries, they play a significant role in the early-stage financing of firms. Owing to the informal nature of this financing, its volume is often not known. However, research indicates that the volumes involved may surpass those supplied by venture capital funds. Business angels are often successful entrepreneurs themselves and can bring significant knowledge and experience to the investee. Non-financial resources provided by angel investors typically include assistance in business strategy, the search for additional finance, recruitment of key staff and enterprise governance. The level of control is frequently lower than what is demanded by venture capitalists, and the duration of these informal investments is often longer. Business angels are not averse to investing in technology-based firms.

In many countries, business angels appear to be more geographically dispersed than the formal venture capital sector. However, a study of the regional distribution of informal venture capital in Sweden found it concentrated in metropolitan areas and university cities (Avdeitchikova, 2009). It also found that business angel investment is proportional to the regional rate of new business creation and the presence of technology-based firms. In more peripheral regions, business angel investment relates positively to the share of the local population considering starting a business.

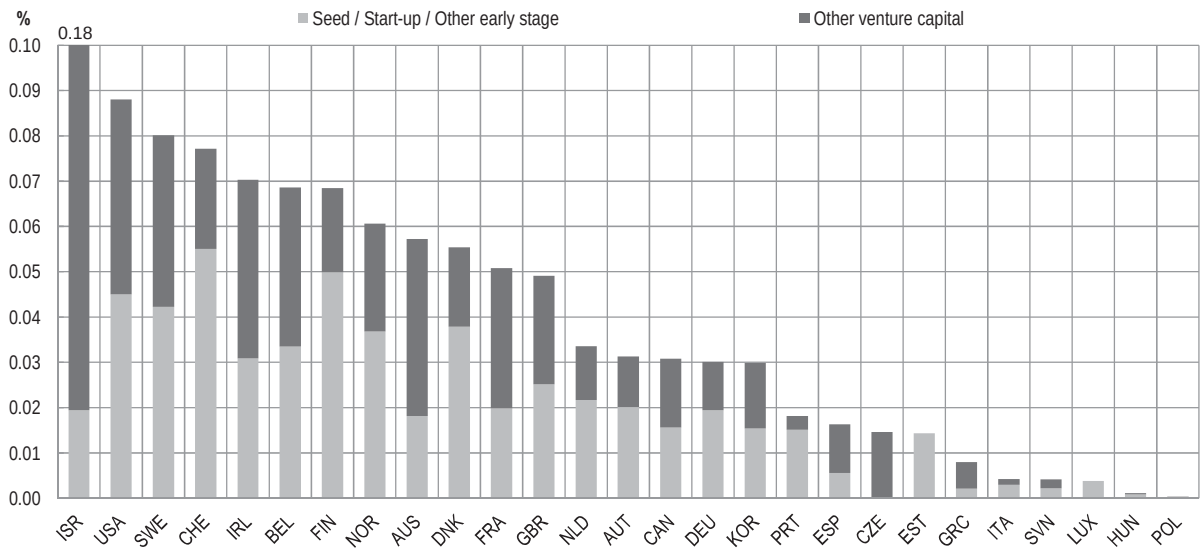
While systematic data on the volume of business angel investment in Sweden are not available, Adveitchikova (2008) and Adveitchikova *et al.* (2006) estimated this to be between EUR 385 million and EUR 450 million a year, or around 1% of GNP. These magnitudes are moderate compared to countries for which similar information is available. Some comparative data on numbers business angel groups and networks are available (Figure 1.19). They suggest that the number of networks per country relates broadly and positively to population size. However, Sweden has a larger number of

networks than countries with comparable or larger populations, such as Australia, Hungary, Italy, the Netherlands, Poland and Turkey.

Nevertheless, despite the significant presence of angel networks, most interviewees held that there is too little business angel activity in Sweden and that too few business angels have a credible track record and expertise and are able to act as lead investors.[10] This situation may be self-perpetuating, because angel investment appears to have a group dynamic, with investors following the lead of prominent peers (the "bandwagon effect").

A survey in early 2009 of representatives of business angel networks, incubators, university holding companies, venture capital companies, co-investment funds and municipal business offices found that most of the 155 respondents considered that the government should further encourage business-angel investments through tax relief, support of specific activities and distribution of information. Many also held that the establishment of co-investment funds with business angels would be useful (Tillväxtverket, 2009).

Figure 1.19. Number of business angel networks/groups, 2009



Source: OECD, calculations based on EBAN (The European Trade Association for Business Angels, Seed Funds and other Early Stage Market Players), ACA (Angel Capital Association), NACO (National Angel Capital Organization) and AANZ (Angel Association New Zealand), March 2011.

1.3.6. Taxation

Tax policy strongly affects returns to innovation and hence the incentive to innovate. The innovative activity of firms is associated with many types and levels of taxation, including indirect taxes, such as value-added tax (VAT) on innovative products, direct taxes, such as income tax paid by researchers and scientists, social security contributions, and taxes on intellectual property. Corporate income (CIT) and capital gains taxes are the most significant for business investments.[11] Decreasing the rate of capital gains taxation increases commitments to new venture capital funds and raises the share of high-technology and early-stage investments in overall venture capital activity (Da Rin *et al*., 2005). A lower capital gains tax rate may also raise the supply of investment opportunities by increasing workers' incentives to become entrepreneurs (Poterba, 1989).[12]

Table 1.5 shows "basic" (non-targeted) central, sub-central and combined (statutory) corporate income tax rates. In recent years, corporate income tax in Sweden has been lowered and now, at 26.3%, the combined corporate income tax rate is in line with the average of the countries covered. Reform measures currently examined by the government include a widening of the tax base to lower the corporate tax rate.[13]

Table 1.5. Corporate income tax rate[1]

	Central government corporate income tax rate[2]	Combined corporate income tax rate[3]
Sweden	26.3	26.3
Austria	25.0	25.0
Canada	16.5	27.6
Denmark	25.0	25.0
Finland	26.0	26.0
France	34.4	34.4
Germany	15.8 (15.0)	30.2
Israel	24.0	24.0
Italy	27.5	27.5
Japan	30.0	39.5
Korea	22.0	24.2
Netherlands	25.0	25.0
Norway	28.0	28.0
Switzerland	8.5	21.2
United Kingdom	26.0	26.0
United States	35.0	39.2

1. Where a progressive (as opposed to flat) rate structure applies, the top marginal rate is shown. 2. This column shows the basic central government statutory (flat or top marginal) corporate income tax rate, measured gross of a deduction (if any) for sub-central tax. Where a surtax applies, the statutory corporate rate exclusive of surtax is shown in round brackets ( ). 3. This column shows the basic combined central and sub-central (statutory) corporate income tax rate.

Source: OECD.

Capital gains from the sale of shares/securities are taxed at 30%, one of the higher rates in Europe. Industry representatives reported that capital gains rules are complex and can lead to locking capital into existing companies.

Features of the tax system that are attractive to business include: capital gains exemptions on sales of subsidiaries; tax-exempt intra-group dividends; full tax relief on interest; the absence of thin capitalisation rules; and comprehensive tax treaties to avoid double taxation with most countries. However, But other elements of the tax code in Sweden may limit entrepreneurship.

One of these elements concerns the way in which stock options are taxed. It is a widely-held view that the Swedish law for stock options is best suited for large listed companies, rather than early stage ventures with their typical uncertainties and high risks. The main contention is that Sweden lacks a system such as that in the United States that enables the issuing of two kinds of options (giving preference shares in early-stage ventures more value than the common shares issued to venture founders and sub-

sequently recruited employees). By comparison, Swedish investors are held to obtain too little ownership for their investments in early-stage ventures. Taxing stock options in a manner analogous to the taxation of earned income may also be problematic, especially given Sweden's high marginal rate of income tax, and the fact that tax deductibility of losses after individuals invest in a new (unlisted) venture is limited.

Work is under way on tax incentives for venture capital, an issue which will be revisited in the 2013 Budget Bill. Aside from lowering taxes affecting venture capital, one of the reported aims of proposals now being considered is more equal tax treatment of investment of own capital and loans.[14] Various experts observed that investors in growth companies would benefit from the opportunities currently available to the forest industry in Sweden (the forest account, *skogskonto*). Because it takes a number of years to build a company, and because gains or losses are calculated for tax purposes in the accounting year in which they occur, there may be significant annual variations in taxes. A model to smooth the variation based on the forest account might be valuable to investors/entrepreneurs.

The Swedish Venture Capital Association (SVCA) has advanced other tax proposals that might make it easier for growth companies to attract investors. One is that companies should be able to receive a tax deduction for investment in growth companies, because many business angels make investments through their assets in companies. For example, through the United Kingdom's Enterprise Investment Scheme, investors receive a percentage of the amount invested in income tax relief, provided that shares are held for a minimum of three years. A further SVCA proposal is to give growth companies the opportunity to defer payment of social security contributions until the company shows a profit.

The administrative burden of tax compliance

The burden of administrative compliance with corporate taxation is relatively low in Sweden. *Doing Business 2012* ranks Sweden 50 out of 183 economies in this connection, ahead of the overall 62 for OECD economies. On average, firms make four tax payments a year and spend 122 hours a year filing, preparing and paying taxes.

1.3.7. Infrastructure

Physical infrastructure is important for business and for innovation in a variety of ways. Road infrastructure, for instance, facilitates trade and competition and can therefore encourage investment and innovation.[15] Transport delays can affect just-in-time production processes. However, in high-income economies such as Sweden, concerns about innovation-related infrastructure tend to focus on information and communication technologies.

ICT infrastructure, especially high-bandwidth connectivity, affects innovation and broader business outcomes in a variety of ways. For instance, Internet use is associated with superior performance in small firms. Data from France show that Internet-using firms report higher revenue per salaried person, higher added value, superior job creation and a proportionately greater number of registered patents. Evidence from the United States also suggests that small firms that use the Internet have higher revenues than non-users. More generally, ICT infrastructure facilitates innovation by enabling the circulation of data and information, whether publicly or privately generated or funded. In many areas of science, research communities use powerful grid computing resources to access large data sets for experimental purposes. ICT infrastructure also facilitates data-driven

delivery of key public services, from management of smart electricity grids and transport systems to efficiency-enhancing patient data in health care. High-speed broadband networks are also the foundation of innovations in cloud and grid computing that centralise computing power and resources across the Internet.

Currently, across the OECD, over 50% of households have broadband Internet access. As Table 1.6 shows, 97% of households in Korea have a broadband connection via a computer or mobile phone (col. 1). Household access in Sweden, at 82.6%, is above both the OECD and EU averages. Business access to broadband also exceeds the EU and OECD averages (col. 2). The increasing popularity of smartphones and tablet computers is driving growth in mobile broadband services. Sweden's standard mobile broadband subscriptions, at 52.2 per 100 persons, are considerably above those of most other OECD economies (col. 3). The goal of the government's broadband strategy is 90% of all businesses and households with access to broadband of at least 100 Mbit/s.

Table 1.6. Selected indicators of broadband Internet coverage

	Household access to broadband (2010) (1)	Business access to broadband (2010) (2)	Standard mobile broadband subscriptions per 100 inhabitants (2010) (3)
Sweden	**82.6**	**88.4**	**52.2**
Austria	63.7	75.0	n.a.
Canada	72.2	94.3	14.4
Denmark	80.1	84.0	27.6
Finland	75.8	93.1	21.6
France	66.8	93.0	30.0
Germany	75.2	89.2	15.3
Israel	n.a.	n.a.	n.a.
Italy	48.9	83.1	26.1
Japan	63.4	79.7	75.3
Korea	97.5	98.6	16.4
Netherlands	77.0	90.0	23.6
Norway	82.6	84.4	62.0
Switzerland	70.8	100.0	39.4
United Kingdom	69.5	87.3	23.2
United States	68.2	n.a.	32.2
EU27	60.8	84.6	n.a.
OECD	62.8	85.7	n.a.

Source: OECD (2011c), *OECD Science, Technology and Industry Scoreboard 2011*.

1.4. The role of innovation in Sweden's economic development: Past and future

1.4.1. Sweden's long-term development trajectory and innovation

Economic development

Sweden's record of development over more than a century – between the 1870s and 1970s – is impressive. Its economy has grown at a rate of 2.4% a year on average, compared to 1.7% for the rest of western Europe and 1.5% worldwide. Only Japan had a comparable record. The other Nordic countries also performed well, with 2% average annual growth. Sweden's GDP per capita in relation to world GDP per capita tripled between 1870 and 1970 (Schön, 2008). In most periods many Swedish regions, including peripheral ones, grew rapidly.[16]

Sweden started to industrialise in the 19th century and gradually became a technologically strong nation. Its development has not been linear, however. The Swedish innovation system has become what it is today through successive waves of development, each characterised by specific drivers of growth and development.

In the mid-19th century industrialisation took off, accompanied by an increasing internationalisation of the economy. International demand for bar iron/steel and timber/wood, but also for oats, supported growth and rationalisation in primary and secondary production.[17] Sweden did not belong to the first wave of industrialising countries, but benefited from a late-mover position and from the uptake of technological advances. As economic historians have noted, Sweden caught up with early industrialising countries such as England, from 1850 to 1970, and subsequently began "forging ahead".[18] The Swedish economy and society were transformed by the introduction of innovative steel processes, modern factories and the construction of railways. This was accompanied by an expansion of exports (mainly agricultural and forestry-based commodities and iron) and of imports of machinery and equipment as well as technological know-how, particularly from the United Kingdom. In parallel, the banking system evolved: 1856 marked the foundation of SEB Banken. The abundance of hydropower also played a crucial role in Sweden's development.

Sweden was then able to participate fully in the second industrial revolution in machinery and engineering, chemicals, and consumption goods. Around 1900, Sweden was a net importer of capital from Europe and a net exporter of labour to the United States.[19] A cohort of knowledge-intensive firms appeared between 1880 and 1910, among them AGA, Asea (ABB), Ericsson, Separator (Alfa Laval) and SKF. As in other countries at the time, such firms were often founded by inventor-entrepreneurs with a background as scientists or engineers.[20] These firms expanded quickly and competed on international markets. Swedish companies became technologically advanced, moving to the frontier in many areas (Schön, 2008; 2009). An important factor in this exceptional growth performance was Sweden's capacity to innovate, based on a good education system. The record of this highly entrepreneurial period contrasts with concerns sometimes voiced today regarding a lack of entrepreneurship. In the 20th century – beginning in the interwar period – "development blocks" evolved around electrical (household) equipment, automotives and services (Volvo, Saab, Electrolux to Tetra Pac, IKEA, H&M). The electronics-ICT "development block" gained momentum from around 1970.

The period between 1945 and 1975 has been described as the golden era of the Swedish economy, with high growth, low unemployment, increasing income and living standards and a high degree of social equality. The foundations for this period had been

laid well before. The 1938 Saltsjöbaden agreement between employers and labour unions set out the principles which have guided wage bargaining and social policy.[21]

However, following three decades of prosperity, the Swedish economy's growth trend eventually started to slow. Sweden was affected by the crises of the 1970s and 1980s, although later than other countries. From the mid-1970s to the mid-1990s Sweden went through a period of low growth. In the early 1990s Sweden, alongside neighbouring Finland, was hit by a deep recession.[22] Sweden lost its position among the leading OECD countries in terms of GDP per capita, sliding from fourth to fifteenth place between 1970 and 2003. Both the private and public sectors seemed unable to create sufficient jobs and innovation (Marklund *et al.*, 2004, p. 12).[23]

A number of traditional industries with well-paid jobs (such as shipbuilding, steel or mechanical engineering) found themselves in a difficult position when confronted with increasing international competition, unfavourable cost structures[24] and less competitive products. Industrial policy initiatives in the 1970s stalled as defensive – and expensive – attempts to save industries often did not lead to lasting success. Important industries, including electronics, chemicals/pharmaceuticals or the automotive industry remained internationally competitive, however.[25] Technology adoption in both manufacturing and services seems to have been efficient (Marklund *et al*., 2004, p. 21). In the 1980s, Sweden succeeded in gradually adapting to the new global environment, successfully modernising some "old" industries such as pulp and paper while discarding (a large part of) others such as shipbuilding.

The "Swedish model" came under increasing strain and underwent a profound reform during the 1980s and 1990s (Erixon, 2011; Bergh, 2011). Together with Sweden's accession to the European Union,[26] institutional changes took place in areas such as liberalisation of product and capital markets, wage formation and procurement rules. Formerly public domains were opened to private providers and, overall, the services sector received more attention. Liberalisation paved the way for a wave of international mergers and takeovers of Swedish firms from the mid-1980s on. Emphasis turned from the public sector to various forms of private initiative, by fostering entrepreneurship and finance. Public research and technology policy responded by partly replacing the traditional reliance on sectoral approaches with more generic instruments of R&D support, but support for universities as knowledge providers remained strong. Investment started to shift from physical goods towards intangibles (such as R&D). Overall the main indicators for Swedish R&D inputs and performance maintained their high level or showed only minor decline in the 2000s. In most respects, the country managed to keep its place in the top tier.

Together, these reforms and adjustments helped turn Sweden's economic performance around in the 1990s, and growth of GDP and productivity accelerated (Bergh, 2011). The economy rebounded in the mid-1990s, and Sweden experienced a "productivity miracle" during the following decade. It then continued on a successful path during most of the first decade of the 21st century. Among OECD economies, only a few (such as Korea and Ireland) recorded higher (labour) productivity growth than Sweden (Erixon, 2011, pp. 65 *ff.*). This improvement took place in manufacturing, with ICT as a powerful driver of growth.

Some salient features of Swedish innovation

A characteristic, long-term element of Sweden's economic development and innovation system has been co-operation by the state and industry to foster innovation in and around "development blocks" (Dahmén 1991; Schön, 2009). In this context, "development pairs" of government agencies and leading companies formed stable relationships, mainly related to innovation-oriented public procurement in areas such as rail transport, power grids or electronic telecommunication switches (Edquist *et al*., 2000; Fridlund, 2000a; Fridlund, 2000b; Arnold *et al*., 2008). Mutual trust, co-operative specification of advanced needs and sufficient time for experimentation created opportunities for new developments. In some cases customers and suppliers formed joint R&D companies. Further public support came in the form of public research funding and human resource development. Risk sharing and large-scale experimental development allowed for technological advances with a double dividend: the Swedish economy and society benefited from modern, high-performing infrastructures and industrial partners strengthened their international competitiveness in innovative product segments. This approach was also taken in fields such as nuclear energy and defence.[27]

Public procurement was therefore a major driver of innovation and economic development for an important part of Sweden's modern history. This is evident in the so-called "development pairs" involving business firms and public/private partners, some of them engaged in very long-term relations, *e.g.* ASEA-Vattenfall for electricity transmission, AXE digital switches and the GSM standard (Ericsson-Televerket), etc. A framework for interaction and co-operation among government and social partners and the sharing of productivity gains as well as high levels of education and skills provided critical pillars.

A new global environment

Overall, the "Swedish model" has adapted remarkably to changes in the international environment and to related social, technological and economic challenges. Sweden's institutional, economic and financial conditions allow it to face the future with confidence. Much current Swedish debate focuses on the long-term sustainability of its achievements in a world economy transformed by globalisation.

Over the last two decades, important parts of Swedish industry have become part of non-Swedish MNEs with headquarters outside of Sweden. Large firms based in Sweden, which have long relied on international markets, have become truly "global" in reach and orientation. Irrespective of their ownership, these enterprises follow their global corporate strategies. Although Sweden has benefited from internationalisation, there are concerns that this will become harder as globalisation develops further, and there is a perception of a growing exposure to risk.

Sweden has nurtured and maintained a strong industrial base with an exceptionally broad range of products and economic activities. In addition, Swedish manufacturers have successfully integrated sophisticated service components into their products (*e.g.* engineering, maintenance, network management), and market services have grown dynamically. Sweden's large and highly developed services sector accounts for an increasingly large share of aggregate employment. Enhancing its efficiency will be necessary to maintain high productivity growth and to ensure high-quality service delivery at affordable cost. Sweden's currently strong position should not, however, lead to complacency: the world is changing rapidly and further challenges lie ahead.

1.4.2. Recent global trends in innovation

As the OECD's *Innovation Strategy* (OECD, 2010) demonstrated, innovation today has a number of noteworthy characteristics:

- *Innovation increasingly occurs in a system – including different parts of the same firm – rather than in isolation.* In the past, innovation in larger firms frequently took place independently of the overall business strategy, was performed in-house, with research outputs incorporated in the firm's products and services, and product revenues were used to finance successive cycles of in-house R&D. Today, however, innovation efforts are typically subsumed under the firm's broader strategy goals, and fewer firms undertake curiosity-driven research. Technologies may be developed cooperatively or acquired, and the innovation effort may involve users. The research output may be incorporated in products and services and externalised, for instance through licensing or venturing activities. In many countries, co-invention by domestic firms has also been a growing phenomenon. In Sweden, the share of co-invented patents has increased substantially since 1996-98.
- *As technologies become more complex, and more combinatorial, innovation becomes more multidisciplinary.* For example, a mapping of scientific fields that influence innovation in green technologies, as measured by patenting, shows that areas such as chemistry and material sciences are more important for green technologies than research on energy and the environment.
- Owing to structural changes in OECD economies – and with a large part of overall labour productivity growth in many countries coming from services – much innovation is occurring in the services sector. Keys to more rapid innovation and productivity growth in the services sector include better business regulation (on both entry and operations), policies to facilitate ICT adoption, and human capital development. Governments also need to ensure that technology diffusion policies address the needs of service firms, as these sometimes focus on manufacturing.
- *Science is increasingly networked internationally and innovation increasingly involves cooperation across borders.* Survey evidence suggests that between 2004 and 2006 just under 40% of innovative firms in Sweden collaborated on innovation, the third highest figure among countries for which data were available, after Finland and Chile. Slightly less than 23% of innovating firms collaborated with international partners, the fourth highest figure among OECD countries. Over time, Sweden has seen an increase in the share of R&D financed from abroad; in 2007, at 9.3% of gross domestic expenditure on R&D (GERD), it was three times what it had been in 2001. Just under one-fifth of Patent Cooperation Treaty (PCT) patent applications in 2007-09 involved international co-inventors. International co-operation on patenting has recently increased, but 2011 data suggest that it is still somewhat below the OECD median. However, international co-authorship of scientific articles in 2011 was above the OECD median. Recent years have seen a large rise in internationally co-authored scientific publications/articles. Sweden's science profile is one of the strongest in the OECD area.

- *The geography of innovation is also changing*, in particular with the People's Republic of China's increased presence in the global market, but also that of Brazil, the Russian Federation and India. Between 1996 and 2007, scientific articles from the BRICS[28] countries more than tripled.
- *Intellectual property and the system of intellectual property rights (IPR) have assumed new prominence.*[29] IPR policy issues have many aspects (Box 1.3). A relevant indicator in connection with Sweden's IPR system is pendency time at Sweden's Patent Office. Pendency time refers to the time elapsed between the patent application and the patent grant. In recent decades, the world's major patent offices have seen significant growth in numbers applications. Pendency times have risen in some countries and fallen in others. Average pendency times have risen at the European and US Patent Offices and fallen at Japan's Patent Office since 1994. In Sweden, between 2000 and 2009, pendency time fell by 23.6% (WIPO, 2011), one of the largest declines among OECD economies.[30]
- *The advent of significant user-based innovation.* With the growth of the Internet user innovators are connected in online communities that can share, develop, and rapidly disseminate ideas. In many industries (*e.g.* software, music and video games), user-led innovation has become part of firms' business strategies: firms encourage users to innovate and often give them the tools to do it (*e.g.* Apple, Facebook). In the United States, the so-called "maker movement" is an out-growth of digital culture made possible by an array of new tools and electronic components, and uses 3-D printers to integrate the physical and digital worlds. While it mainly involves hobbyists so far, the movement is being hailed as a possible catalyst of structural change in US industry.[31]

1.4.3. New sources of growth: Knowledge-based capital

An important, and relatively recent, shift in policy thinking involves the recognition that innovation is more than R&D (OECD, 2010). While research on innovation has traditionally focused on universities, laboratories, scientists and R&D workers, recent literature has cast a spotlight on the importance of so-called "knowledge-based capital" (KBC). KBC comprises intangible assets used in production and owned by business, such as computerised information (software and databases); innovative property (patents, copyrights, trademarks, designs; Box 1.3); economic competencies (including brand equity, firm-specific human capital, networks of people and institutions; the organisational know-how that increases enterprise efficiency; and aspects of advertising and marketing). New measurement and analytical efforts have drawn attention to the large and growing scale of business' investments in KBC, and have identified these investments as a key source of changes in productivity and GDP.

Box 1.3. The role of design

Sweden's long-standing interest in design and the role of design in contemporary economies and as an area of policy has been highlighted in recent work on innovation carried out by the Royal Swedish Academy of Engineering Sciences (2011). Various studies have drawn attention to the recognised economic importance of design:

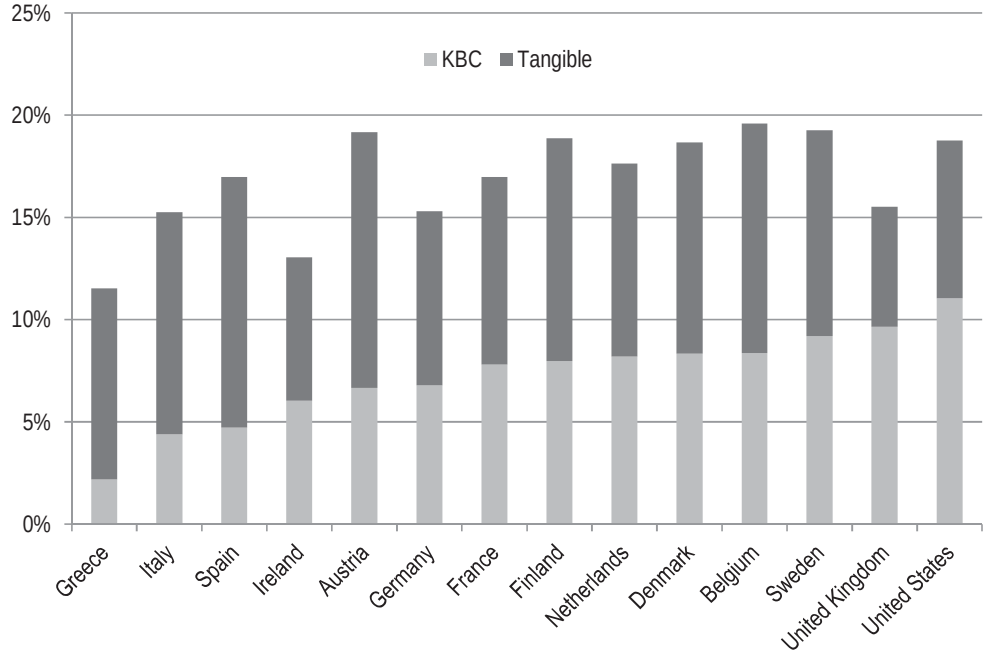
- Beyond the physical appearance of products, design is often integral to all stages of the business process, from basic research to manufacture, marketing and after-sales services. One study in the United Kingdom suggests that design spending might be more than twice as large as business spending on R&D.
- Design appears to play an important role in innovation and firm performance. A number of world-beating products owe at least part of their success to different aspects of design. For instance, research published in 2010 indicated that the iPhone had added around USD 30 billion to the value of the Apple Corporation, only 25% of which was attributable to patentable technology stemming from R&D. Much of the rest came from Apple's innovations in design, marketing and management. Companies in traditional industries such as textiles, apparel and furniture can also succeed on the basis of their design competencies. For instance, Italy has long had a successful furniture industry largely based on SMEs with competitive advantages in design.
- In 2007, almost half of businesses in the United Kingdom believed that design contributes to increased market share and turnover. In 2004, among UK firms that considered design integral to their business, nearly 70% had introduced a new product or service in the previous three years (compared to just 3% of companies in which design played no role).
- The "*Europe 2020 Flagship Initiative – Innovation Union*" includes design among its ten identified priorities. Further afield, China, India, Korea and Singapore have all enacted design policies and consider design to have strategic economic importance.

The European Union has recently supported data gathering and research on KBC,[32] and the OECD is currently examining the measurement and policy implications of KBC. This research has led to a number of stylised facts:

- Many advanced economies have progressively become intensive users of KBC. This reflects long-term structural, educational and technological changes in OECD economies (Box 1.4).
- In Sweden, the United Kingdom and the United States, investment in KBC now almost matches, or exceeds, investment in traditional capital such as machinery, equipment and buildings. These investments are large relative to national income. The most recent data suggest that Sweden is one of the OECD economies with the highest business investment in KBC as a share of GDP (Figure 1.20). Between 2006 and 2009, in most of the countries included in Figure 1.21, business investment in KBC rose further as a share of GDP, or declined less, than investment in physical capital. In Sweden, investment in tangible capital fell from 10.6% of GDP to 10.0%, while investment in KBC as a percentage of GDP remained nearly unchanged.
- There are big differences across countries in the share of business investment in KBC. These differences are positively correlated with income per capita.

Figure 1.20. Business investment in KBC and tangible capital, 2009

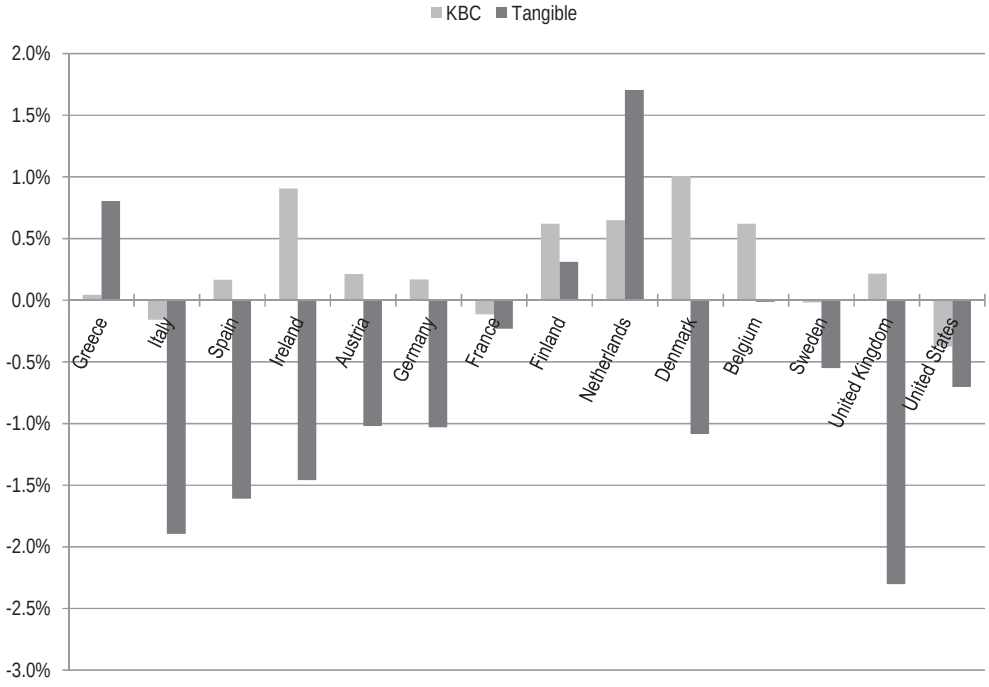
Percentage of GDP



Source: Corrado, C., J. Haskel, C. Jona-Lasinio and M. Iommi (2012, forthcoming), "Joint database on intangibles for European policymaking – data from INNODRIVE, COINVEST and the Conference Board".

Figure 1.21. Change by type of business investment, 2006-09

Percentage points of GDP



Source: Corrado, C., J. Haskel, C. Jona-Lasinio and M. Iommi (2012, forthcoming), "Joint database on intangibles for European policymaking – data from INNODRIVE, COINVEST and the Conference Board".

Box 1.4. Why is business investing more in knowledge-based capital?

There are a number of possible explanations for the rise in the intensity of business investment in KBC:

- With rising educational attainment, OECD economies have accumulated a growing stock of human capital. Human capital subsumes KBC. For instance, patents are a legal device for securing the intellectual property associated with innovations emanating from human thought. A growing stock of human capital permits and complements the production and use of KBC.
- Many products are becoming more knowledge-intensive. In the automotive sector, valuable trade secrets now lie in the electronic controls that regulate the operation of motors, generators and batteries. Huge volumes of computer code are required, especially by hybrid and electric vehicles: the Chevrolet Volt plug-in hybrid uses about 10 million lines of computer code.
- In a context of global integration of markets and deregulation, sustained competitive advantage is increasingly based on innovation, which in turn is largely driven by investments in KBC. For instance, research shows that absolute levels of patenting, R&D, IT and management quality have risen in firms that are more exposed to increases in Chinese imports. In sectors particularly exposed to Chinese imports, jobs and survival rates have fallen in firms with lower patenting intensity, but have been relatively protected in high-technology firms.
- The fragmentation and geographic dispersion of value chains, as well as the increased sophistication of production processes in many industries, have accentuated the importance of KBC, in particular organisational capital (*e.g.* Wal-Mart's computerised supply chains, Merck's multiple R&D alliances).
- Businesses have made major investments in new ICTs. These have required complementary investments in forms of KBC such as new business process skills.
- New ICTs may themselves make some types of KBC more valuable to firms. For example, when consumers can buy on line, rather than face-to-face, a brand and a reputation for reliable service gain additional importance. For instance, 99% of the time, at least one Internet bookseller offers a lower price than Amazon, but Amazon retains its large market share on account of its reputation for customer service.
- The growth of the services sector has amplified the importance of KBC because many service-sector firms rely heavily on the use of intangible assets.

- Major differences in the composition of business spending on KBC also exist across countries. The variations may reflect underlying differences in economic structure.
- Almost all macroeconomic and microeconomic studies, covering various time periods, find a positive correlation between investment in intangibles and changes in growth and productivity. Using a growth accounting analysis, Edquist (2011) shows that in Sweden intangible investment accounted for almost 30% of labour productivity growth in manufacturing in 2000–06.
- The observed sources of macroeconomic growth can change significantly if business spending on KBC is reflected in national accounting systems. Ignoring or wrongly measuring KBC is likely to lead to a distorted picture of changes in economic growth and productivity and their causes.
- Econometric research has also established links between firms' investments in a range of forms of KBC and key business outcomes.
- KBC is still poorly measured. With respect to many intangibles the development of internationally comparable data is in its infancy.

- The rise of intangibles and their central role in growth and the knowledge economy raise questions about the adequacy of current policy settings.

Business investment in KBC underpins the entire knowledge economy and it is affected by many areas of policy. Framework conditions are important, as they provide the economic context for investment in KBC. Well-designed framework policies can facilitate the reallocation of resources to new sources of growth, including those based on KBC. While analysts are still seeking to identify optimal KBC policies, it is clear that the critical framework policies include tax, competition, education and training, intellectual property rights, corporate reporting of investments in KBC, and an array of policy settings that affect access to finance for KBC-intensive firms. Attention must also be given to complex regulatory issues, for instance in connection with data privacy and security.

Notes

1 *www.oecdbetterlifeindex.org/countries/sweden/*.

2 RCA is usually defined as a country's share of world exports in a particular commodity or industry, divided by the share of that country's world exports in all commodities: $RCA_{i,c} = (X_{i,c}/X_{i,\ world})/(X_{total,\ c}/X_{total,\ world})$, where $X_{i,c}$ and $X_{i,\ world}$ are respectively the exports of industry *i* by country *c* and the world, while $X_{total,\ c}$. and $X_{total,\ world}$ refer to total (manufacturing) exports by country c and the world. A value larger than one indicates that country *c* possesses a comparative advantage and is specialised in industry *i*, while a value smaller than one points to a comparative disadvantage.

3 *www.tillvaxtanalys.se/en/statistics/new_enterprises/article0004.htm*l.

4 Results from the 2008 Entrepreneurship Barometer can be found on the website of the Swedish Agency for Economic and Regional Growth (Tillväxtverket), *www.tillvaxtverket.se/huvudmeny/faktaochstatistik/entreprenorskapsbarometern/attitydertillforetagande.4.21099e4211fdba8c87b800017530.html.*

5 The World Bank's Doing Business surveys differ in approach from the OECD Product Market Regulation (PMR) Database presented below. The World Bank (2011) notes that the Doing Business methodology has some limitations, among them the scope of factors that are important to business and covered in the survey. For reasons of international comparability, the indicators refer to a specific type of business, generally a local limited liability company operating in the largest business city.

6 The "getting credit" dimension includes the strength of legal rights, the depth of credit information, and the coverage of the public registry and private credit bureau. The "paying taxes" dimension includes the number of tax payments for a manufacturing company (adjusted for electronic or joint filing and payment), the time required to comply with three major taxes and the total tax rate. The "enforcing contracts" dimension encompasses information on the number of procedures needed to enforce a contract through the courts, and the time needed to complete procedures. However, even when high, such rankings do not automatically imply a significant constraint on business. For instance, reducing the number of days required to start a business might be a particularly valuable goal when time requirements are excessive. Reducing the time required from 20 days to 10 may result in a better ranking. But this might have no incidence on the real-world decisions of would-be entrepreneurs, for whom the choice of forming a business is unlikely to be greatly influenced by a short additional waiting period.

7 The effect of competition in product markets on innovation activity that is predicted by economic theory is somewhat ambiguous: competition among incumbents can stimulate innovation, but the possibility of gaining a certain degree of market power may also provide a strong incentive to innovate (the so-called Schumpeterian effect). Aghion *et al.* (2005) found that the degree of product market competition bears an

inverted U-shaped relationship to innovation, with the Schumpeterian effect dominating at higher levels of competition.

8 Beyond loans and equity, only 10% of Swedish enterprises requested "other sources of finance" in 2010 (*i.e.* finance other than loans or equity: leasing; factoring; bank overdraft; subsidised loans; subsides by government; foreign government bodies or international organisations; trade credits (by suppliers); advance payments (by customers); international trade or export finance facilities; mezzanine or hybrid financing; other finance types and sources).

9 Of course, this contraction, especially in early-stage finance, has occurred worldwide.

10 A number of reasons have been given. Some interviewees considered that elements of the tax code play a role in the limited scale of business angel activity (*e.g.* limited tax deductibility of losses incurred by individuals investing in a new unlisted venture). Syndication of business angels, which spreads risk and augments resources, is considered underdeveloped (Andersson, 2011). Some analysts pointed to the legal framework, such as the lack of a legal associational form for reporting to the Swedish Securities and Exchange Board as a joint business angel company for organised venture investing. Also reported to be lacking is an efficient specialised limited partnership arrangement for small venture capital funds. While there is general limited partnership legislation, experts find the way in which taxation of value added combines with tax transparency both complex and costly. For a fund of about EUR 10 million about 1% of the fund will be spent on legal costs without any certainty that the tax authority will eventually accept the design of the fund. Another factor holding back business angel activity may be insufficient size and quality of the deal flow proposed to informal investors.

11 Overall, Sweden has one of the highest average tax wedges in the OECD, and one of the highest standard rates of value-added tax (OECD, 2011a), although during the past year the government decided to lower VAT on services for restaurants and catering (from 25% to 12%).

12 Rather than reduce all forms of capital gains taxation, many countries have introduced lower rates of capital gains taxation on certain types of business asset, such as qualifying small firms, held for specified periods.

13 The results of an enquiry on this matter are due to be reported no later than 1 November 2013.

14 One of the proposed reforms is the introduction of an allowance for corporate equity (Sorenson, 2010). It would allow companies to deduct an imputed normal return on their equity from taxable corporate income, similar to the deduction for interest on debt. The government is also reported to have received a proposal on tax conditions for individuals who invest in unlisted companies. It includes: a tax reduction of 20% of the investment at the company's formation, or at new issues, with a maximum tax credit of SEK 100 000; and a dividend deduction for companies that distribute profits to private individuals.

15 To illustrate the positive association with investment demand, Egeln *et al.* (1997) show that public traffic infrastructure has helped to determine the distribution of start-up activity across Germany's regions.

16 An important factor in this remarkably even geographical distribution of benefits over nearly a century – until urbanisation became a dominant aspect of development

– may have been the high investments in railways and electricity grids (Henning *et al.*, 2010).

17 Before 1850 Sweden undertook a number of reforms, including the liberalisation of agricultural trade and the improvement of the school system.

18 Schön (2009) on whom, among others, this section draws.

19 Between 1820 and 1930, one and a quarter million people emigrated from Sweden to the United States. In relative terms this was only surpassed by Norway and Ireland (Hall, 1999, p. 844).

20 Around 1900, mechanical engineering became a prime source of industrial growth. While the industry accounted for 3% of Sweden's exports in 1880, it expanded constantly to pass the 10% mark in 1910 and reach 20% in 1950 (Edquist and Lundvall, 1993, p. 271).

21 For the long-term effects and Swedish labour market policy, see Erixon (2011, pp. 15 ff). Moreover, social compromise was coupled with powerful narratives of modernity and feasibility of technocratic solutions (Lundin and Stenlas, 2010). Expert elites oversaw long-term planning and held strong positions in the powerful government agencies in charge of policy delivery.

22 "The fall in Swedish GDP growth in 1991-1993 was larger than that during the Great Depression in the early 1930s. And the employment decline was the largest ever in the history of Swedish industrialism" (Erixon, 2011, pp. 22 ff.). This meant a steep rise in unemployment from 1.7% to 9.3% between 1990 and 1994.

23 This relative decline provided the background for recurrent discussions of a supposed "Swedish paradox": while R&D expenditure remained high it did not seem to yield sufficient "output" in terms of growth and jobs, or other measures. Some economic historians have argued that the "paradox" has to be interpreted in the framework of long economic and technological cycles. This view tends to predict a delayed but finally successful return to technologically induced growth, in terms of rationalisation and restructuring patterns (Schön, 2009). Others claim that long-lasting problems persist, leading to persistently low innovation input/output ratios (*e.g.* Bitard *et al*., 2008).

24 However, the unions had long practised a moderate wage policy, based on macroeconomic considerations and a social partnership with the employers.

25 It was claimed that the Swedish model had been able to rationalise existing industries but did not sufficiently encourage overall structural renewal or growth of new sectors (Schön, 2009, p. 5).

26 Sweden joined the European Union in 1995 together with Austria and neighbouring Finland but decided to remain outside the European Monetary Union.

27 Remarkably, Sweden "… a country with a population of between seven and eight million, in the 1950s and 1960s built the fourth strongest Air Force in the world" (Stenlas, 2010, p. 63). Through a national innovation effort, Sweden built its industry to include SAAB Aircrafts and Volvo Aero. Defence authorities collaborated closely with Ericsson on radio communications and there were many claims of spillovers to civilian technology developments.

28 Brazil, the Russian Federation, India, Indonesia, People's Republic of China and South Africa.

29 This prominence has increased owing to recent major corporate acquisitions of intellectual property, such as Google's purchase of Motorola Mobility and Nortel Networks Corp's auctioning of its intellectual patent portfolio.

30 The significance of changes in pendency times requires some interpretation, because they can occur for a number of reasons. For example, an applicant may file with an office but then decide to delay the request for examination. While comparisons across countries may be misleading, one factor behind changes in the same office over time might be changes in the efficiency of application processing (WIPO, 2011). Sweden's pilot action to fund professional consultancy services on intellectual property for SMEs may be relevant here.

31 *The Economist*, Technology Quarterly, December 3rd 2011, p. 3.

32 See *www.innodrive.org* and *www.coinvest.org*.

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Chapter 2

Innovation performance

This chapter reviews Sweden's innovation inputs and outputs and compares them as far as possible with those of other advanced OECD countries. In terms of inputs, Sweden stands out internationally for its high levels of investment in research and development (R&D) (in both absolute and relative terms), the high share of industry in R&D performance and the high share of business R&D funding by multinational enterprise affiliates. Evidence on innovation expenditures suggests that Swedish firms operate at the European technology frontier and that innovation is central to their activities. However, among countries with higher than average R&D intensity, Sweden is the only one to have experienced a notable decline in R&D intensity over the last decade. Business finances a smaller share of higher education R&D expenditure than the OECD norm. In terms of outputs, several indicators confirm Sweden's position as an international centre of scientific excellence and technological leadership. Sweden has more scientific publications and international patents per capita than most OECD countries. However there are indications that formerly dominant sectors are undergoing moderate decline and that Sweden's position is weaker in service innovation and in some measures of impact.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

2.1. Innovation inputs

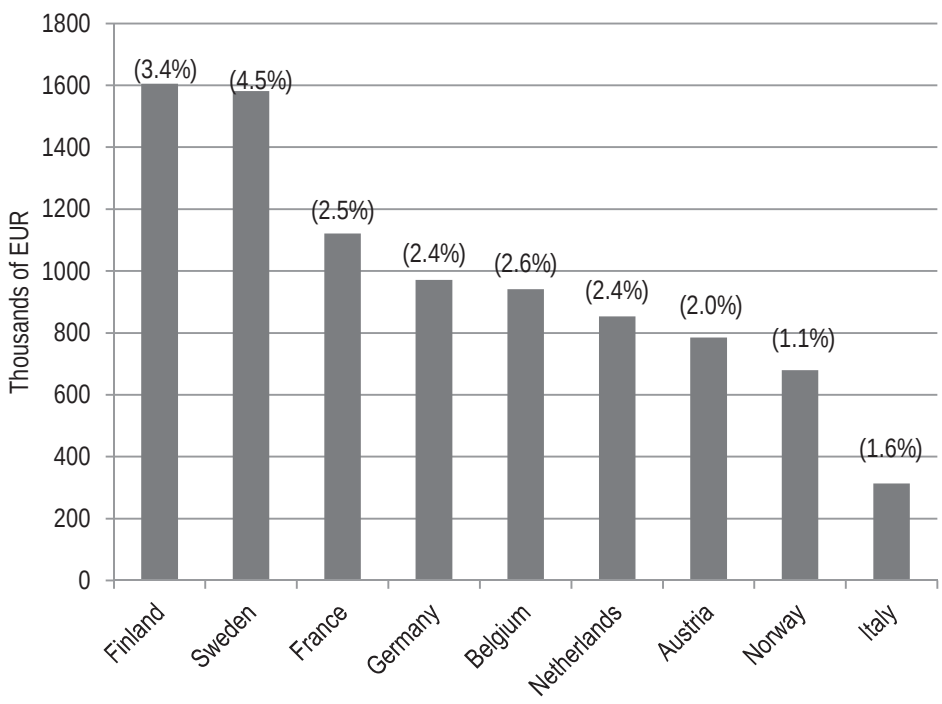
2.1.1. Innovation expenditure

Inputs to innovation include expenditures for the adoption of the latest capital goods, training and other additions to the firm's stock of existing knowledge, such as licensing, as well as resources devoted to formal research and development (R&D). Both absolute and relative levels of resources devoted to innovation matter. Given the indivisibilities associated with new-to-the-world knowledge creation, absolute figures can be suggestive of the capabilities of companies to engage not only in routine upgrading of capital and human resources but also in the generation of globally appealing ideas and their translation into sustainable streams of income. Likewise, relative figures, such as the ratio of innovation expenditures to turnover, can be a revealing proxy of the prominence of innovation among the range of firms' activities.

Figure 2.1 presents average innovation expenditure per company (among companies that reported some innovation activity) and the corresponding percentage of turnover for Sweden and a selection of other countries for which comparable information was available. Finland and Sweden lead, with the largest share of innovation expenditure in the comparator group. In terms of innovation expenditures as a percentage of turnover, Sweden clearly leads with 4.5%. Combined, the two indicators suggest that Swedish firms operate at the European technology frontier and that innovation is central to their activities.

Figure 2.1. Average innovation expenditure per innovating company 2006-08

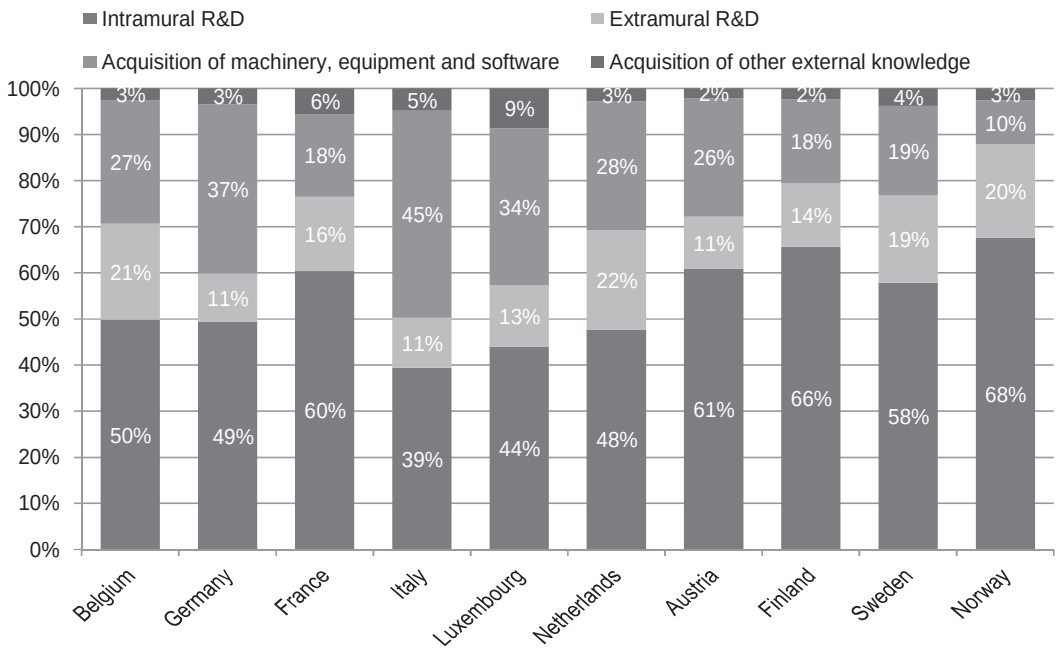
Percentage of turnover in brackets



Source: OECD, based on Eurostat (2012).

Figure 2.2 shows a breakdown by type of expenditure, including intramural R&D, extramural R&D, acquisition of machinery, equipment and software and acquisition of other external knowledge. Norway and Finland lead the group with respect to the share of innovation expenditure devoted to intramural R&D. Sweden has a share comparable to that of France, and a more equal spread of expenditures between various types. Indeed, compared to other countries with high R&D intensity, such as Finland and Germany, Sweden has relatively generous shares of expenditures on both extramural R&D and acquisition of machinery, equipment and software and acquisition of other external knowledge. Sweden's small share of expenditure devoted to the acquisition of other external knowledge is common among countries with high R&D intensities.

Figure 2.2. Innovation expenditures by type

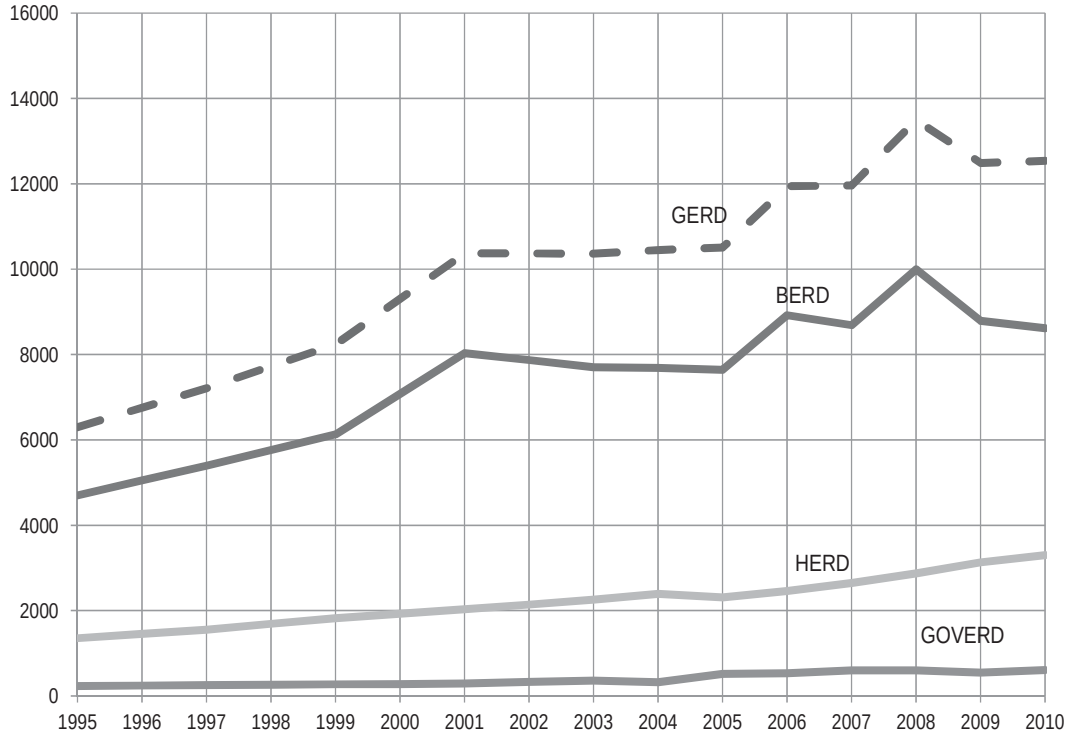


Source: OECD, based on Eurostat (2012).

2.1.2. R&D expenditure

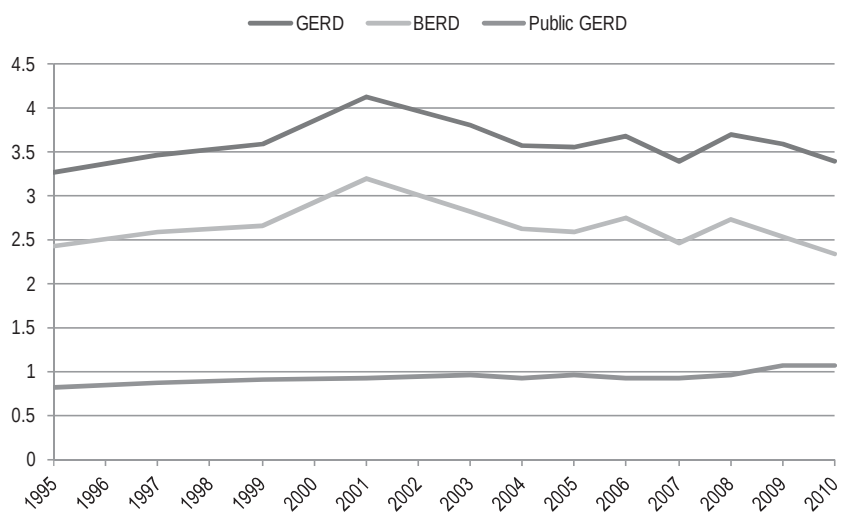
In absolute terms, Sweden's gross domestic expenditure on R&D (GERD) totalled USD 12.5 billion (current prices, PPP) in 2010, a level close to that of the Netherlands (USD 13 billion) or just over half that of Italy (USD 24.3 billion) or Canada (USD 24.1 billion) (OECD, 2012). GERD has risen from just over USD 6 billion in 1995, and the trend has generally been positive over time. There was however an abrupt decline in 2009 (equal to about 7%), owing entirely to a contraction of business expenditure on R&D (BERD). BERD is, by far, the dominant component of GERD, followed by higher education expenditure on R&D (HERD) and government expenditure on R&D (GOVERD). Starting from a relatively low level, HERD and GOVERD have been on a mildly positive trend over time, with HERD growing marginally faster than GOVERD. The consistency with which HERD and GOVERD have increased over time suggests that most of the variability in GERD is due to fluctuations in BERD.

Figure 2.3. Sweden's GERD and its components, in millions of current dollars (PPP)



Source: OECD Main Science and Technology Indicators 2012/1.

Figure 2.4. Evolution of GERD, BERD and public GERD performed (HERD+GOVERD) as a percentage of GDP

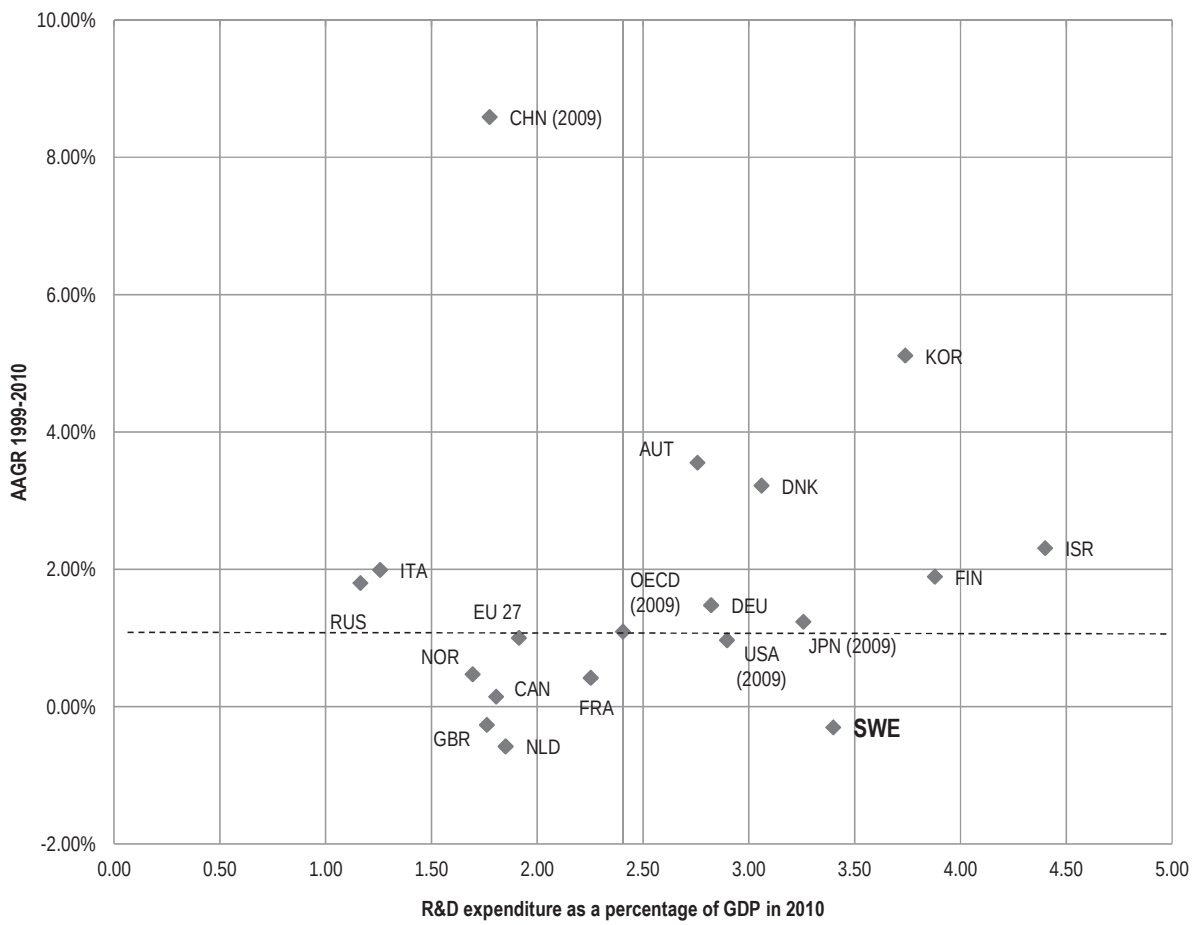


Source: OECD Main Science and Technology Indicators 2012/1.

Over the last decade, GERD as a percentage of GDP (commonly referred to as national R&D intensity) stood at around 3.5% (Figure 2.4). Sweden's high R&D intensity sets the country apart internationally, especially in a European setting. While most of Sweden's EU partners are striving to achieve the Lisbon Strategy objective of 3%, Sweden has set itself the more ambitious target of "approximately 4%" by 2020 (Regeringskansliet, 2012, p. 65). Among OECD countries, only Korea, Finland and Israel present higher R&D intensities than Sweden.

Changes in national R&D intensity over the last decade are almost entirely due to fluctuations in BERD, with public GERD remaining more or less constant. For the latter half of the 1990s, BERD had been on an increasing trend and peaked in 2001 at 3.2%. The short-lived spike in business expenditure can be partly explained by the increased use of external consultants by R&D-performing firms, mainly by Ericsson (Tillväxtanalys, 2011, p. 59). The trend in BERD intensity since then has been moderately negative. The upward trend in public GERD after 2008 has not sufficed to raise national R&D intensity. As a result, Sweden's current R&D intensity is at about the same level as it was at the turn of the century.

Figure 2.5. R&D intensity, 2010 level and average annual growth rate, 1999-2010, selected countries

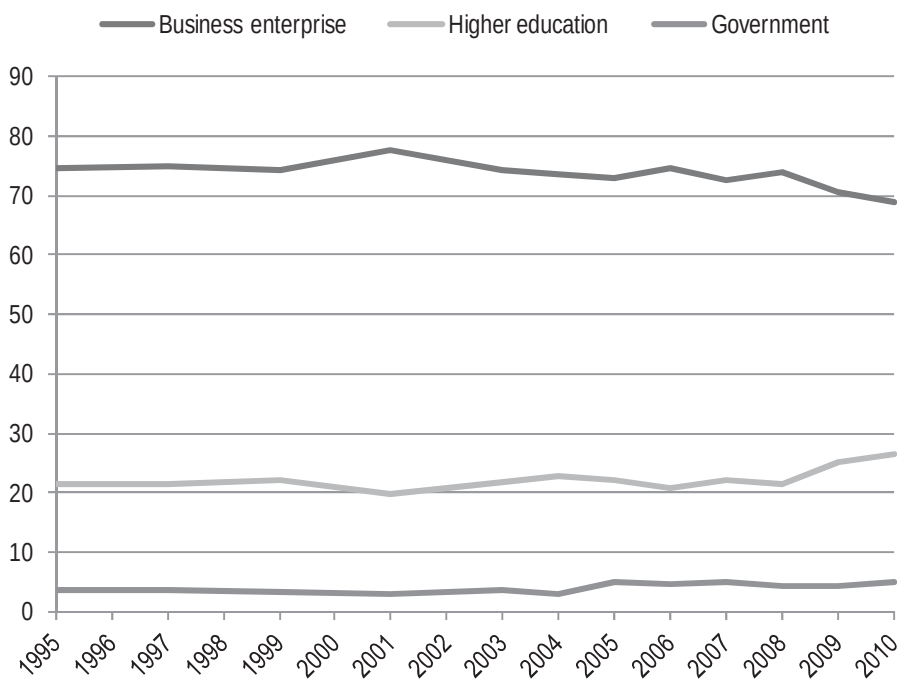


Source: OECD Main Science and Technology Indicators 2012/1.

Figure 2.5 shows selected countries' R&D intensity on the horizontal axis and the corresponding average annual growth rate (AAGR) in R&D intensity over the period 1999-2010 on the vertical axis. In 2009, the OECD average R&D intensity was 2.4%, and the average annual increase between 1999 and 2009 was 1.07%. Although Sweden's R&D intensity of 3.43% in 2010 was well above the OECD average, it recorded a negative AAGR of -0.24% between 1999 and 2010. The negative growth rate can be attributed to decreases in GERD after the peak of 2001 and the more recent crisis of 2008. From an international perspective, Sweden is the only country with a higher than average R&D intensity to face the prospect of long-term decline.

Figure 2.6 shows the distribution of GERD by sector of performance. In 2010, business enterprises conducted about 70% of R&D, with the remainder largely accounted for by higher education (about 20%) and government (about 5%). The government sector's small share has been mostly stable at around 5%, reflecting the relatively minor role of public research institutes (PRIs) in Sweden. The distribution is characterised by long-term stability, with only minor shifts in recent years. Notable among them is the decreasing share of performance by business enterprises after 2008 and the increase in performance by the higher education sector.

Figure 2.6. Percentage distribution of GERD by sector of performance in Sweden, 1995-2010

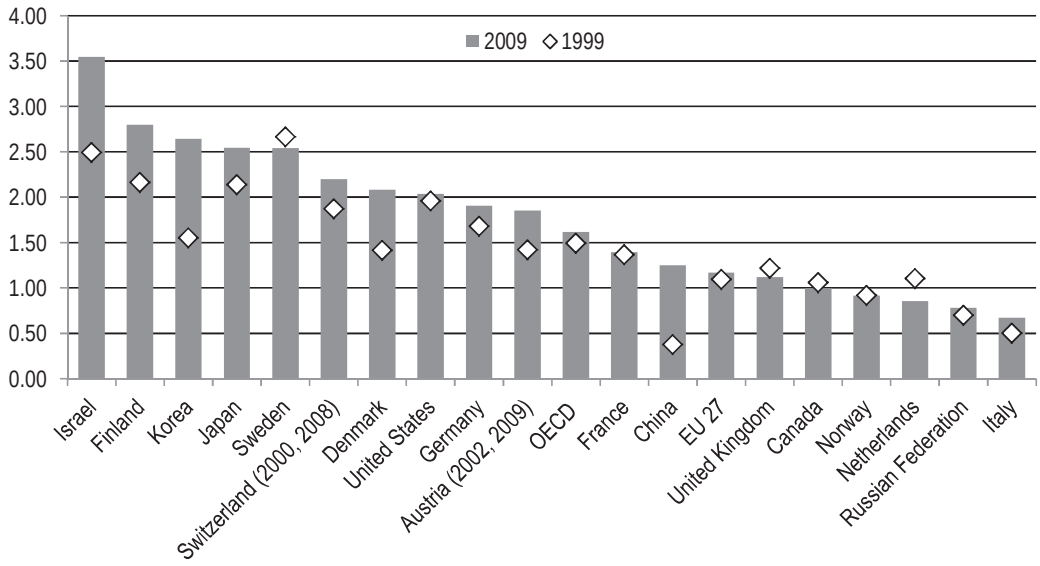


Source: OECD Main Science and Technology Indicators 2012/1.

Figure 2.7 presents BERD as a percentage of GDP (BERD intensity) in Sweden and a selection of other countries. Sweden has one of the highest BERD intensities in the OECD. While Sweden led the comparator group in 1999 with 2.66%, by 2010 BERD intensity had fallen to 2.33%, whereas it had increased considerably in many other countries. By 2010, Sweden had been overtaken by Israel, Finland, Korea and Japan, yet remained well above the OECD and EU averages. Sweden's high BERD intensity is a

reflection of its industrial structure and the size distribution of its firm population. According to the Swedish R&D survey, enterprises with 250 employees and more accounted for over 80% of total R&D expenditures in the enterprise sector (Tillväxtanalys, 2011, p. 59).

Figure 2.7. BERD as a percentage of GDP in selected countries, 1999 and 2010 (or latest available)



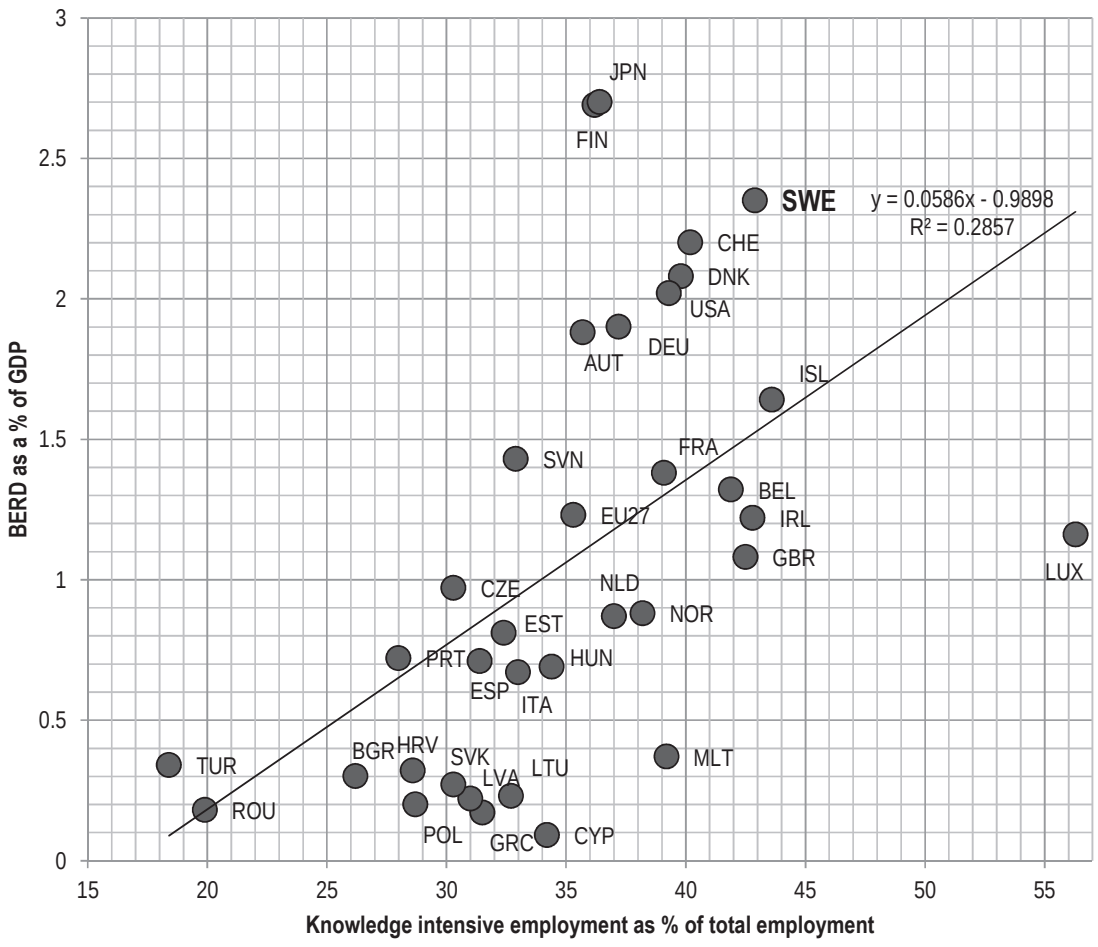
Source: OECD Main Science and Technology Indicators 2012/1.

Not all industrial sectors are equally prone to perform R&D. Pharmaceuticals and the broad range of sectors that are classified as information and communication technology, biotechnology and, more recently, nanotechnology are industries that spend more than average on R&D. Therefore, the propensity of companies to engage in formal R&D activities – and by extension BERD intensity – depends on a country's industrial structure. Sweden's high BERD intensity may reflect its industrial specialisation in sectors that tend to rely heavily on R&D or, alternatively, may be a reflection of other factors, such as relatively favourable framework conditions or the relative size distribution of firms.

Figure 2.8 provides a more nuanced yardstick against which to judge the propensity of firms in Sweden to invest in R&D as compared to firms in other countries. By plotting private-sector R&D intensity against a summary measure of industrial structure (knowledge-intensive employment[1]), Sweden can be compared to countries with similar structures and to the benchmark value (regression line) emerging from all 34 countries considered. Countries positioned on the regression line can be considered to invest on R&D precisely as much as one would expect given their industrial structure; countries above the regression line are investing more on R&D than one would expect on the basis of their industrial structure alone, whereas countries below the regression line are investing less.

Sweden appears to be investing more in BERD than suggested by its industrial structure. It is positioned about the same distance from the regression line as Switzerland and Austria, but closer than Finland or Japan. The relative positions serve as an indirect proxy of the respective countries' overall attractiveness for BERD. Since Sweden performs a proportion of R&D in large firms similar to Finland (81.9% and 82%, respectively), this ranking suggests a specific Finnish advantage over Sweden. Nevertheless, Sweden's above-average performance, even after accounting for its industrial structure, can be seen as confirmation of its relatively favourable conditions for business R&D.

Figure 2.8. BERD intensity given a country's industrial structure, 2010 or latest year

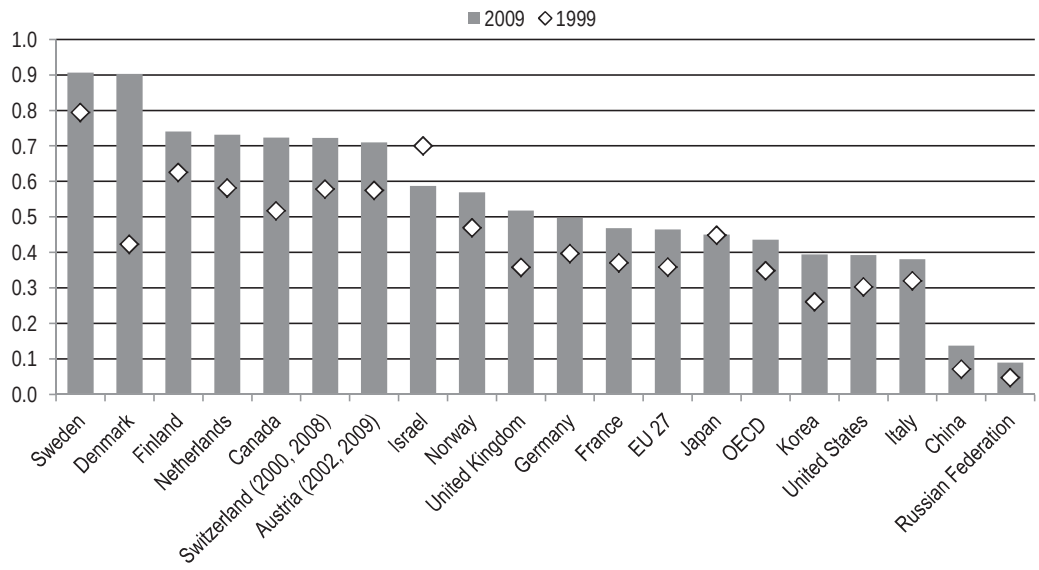


Note: Latest years for which statistics are available are: 2008 for Switzerland, the United States and Japan and 2009 for Iceland and Turkey. For Greece latest figures are 2007 for BERD intensity and 2008 for share of knowledge intensive employment.

Source: OECD, based on Eurostat (2012).

Figure 2.9 shows HERD as a percentage of GDP. Sweden has the second highest share in the OECD, with HERD in 2010 at just under 0.9% of GDP, with only a modest increase over the last decade from 0.8% in 1999. In 2010, Denmark had a slightly higher share than that of Sweden (its HERD intensity having roughly doubled over a decade), followed by a group of countries with developed research systems (the Netherlands, Canada, Switzerland and Austria) all hovering around 0.7% and Finland at 0.8%. Government spending on public research increased notably over 2009-12. This high HERD intensity both supports and is a reflection of the international standing of Swedish higher education institutes, as reflected in their relatively prominent participation in European instruments (Framework Programmes, European Research Council) and good position in international league tables (see section 3.2).

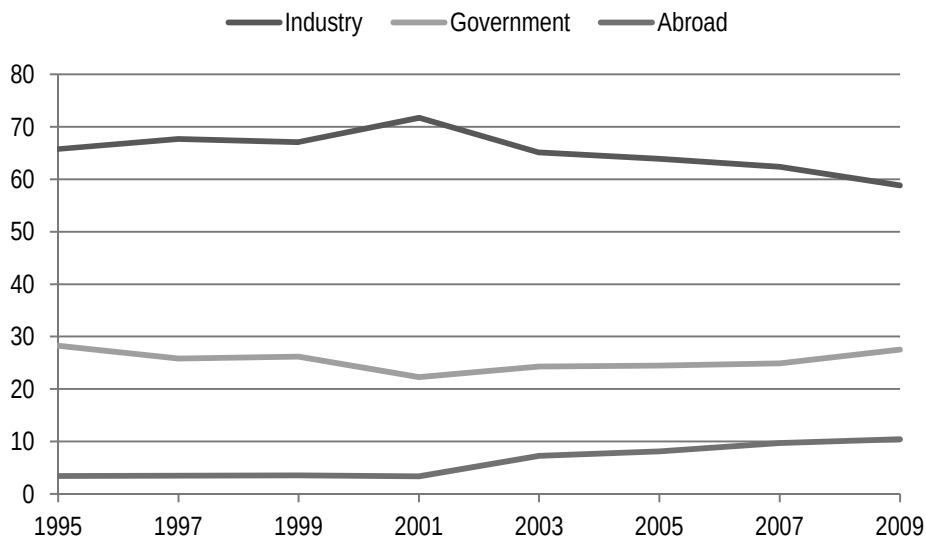
Figure 2.9. HERD as a percentage of GDP in selected countries, 1999 and 2010 (or latest available)



Source: OECD Main Science and Technology Indicators 2012/1.

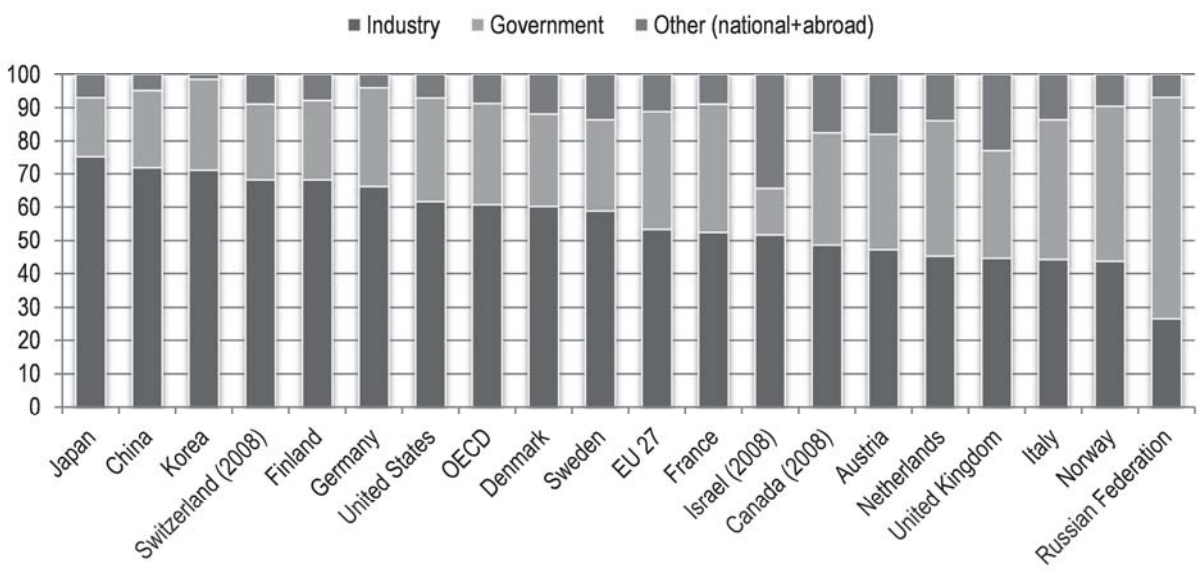
The share of financing of R&D by industry has been on a downward trend since 2003 (Figure 2.10). By 2009 industry contributed 59% of GERD, down from 66% in 1995 and a peak of 72% in 2001. The current share is below the OECD (61%) but above the EU (53%) average (Figure 2.11). The shift in relative shares between institutional sectors over time broadly corresponds to the changes observed with respect to performance (Figure 2.6). Compared to other R&D-intensive countries, Sweden has a relatively balanced portfolio of funders (Figure 2.11). The difference between the share of industry in funding (58%) and performance (69%), can be seen as suggestive of substantial flows of funding between public and business actors.

Figure 2.10. Percentage of GERD financed by different sectors in Sweden, 1995-2009



Source: OECD Main Science and Technology Indicators 2012/1.

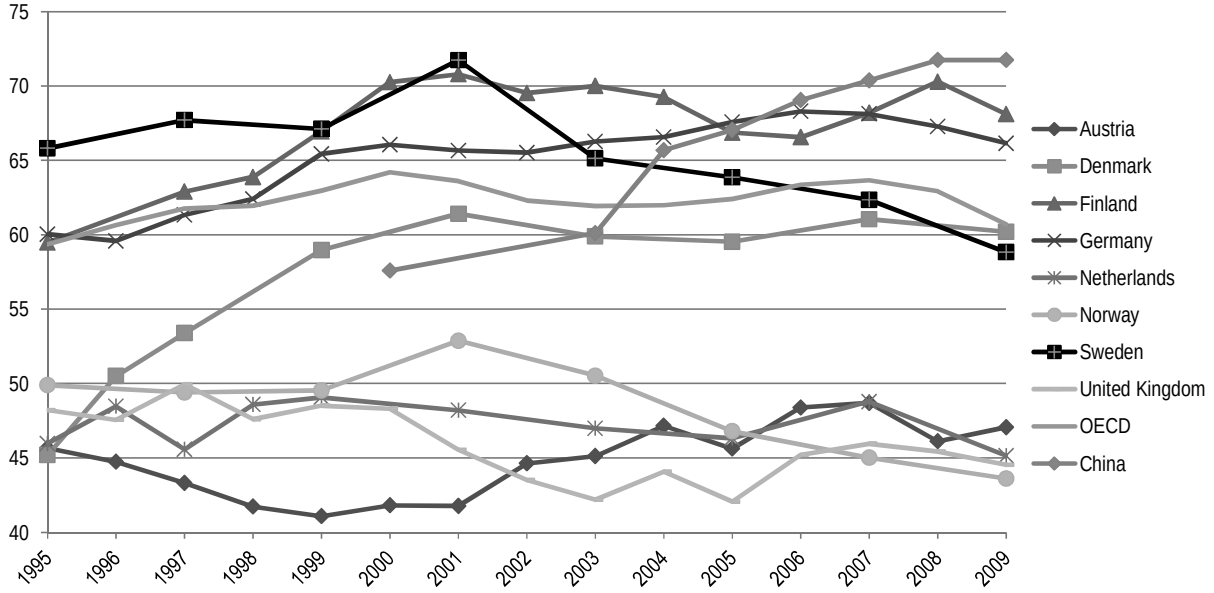
Figure 2.11. GERD by source of funding in selected countries, 2009



Source: OECD Main Science and Technology Indicators 2012/1.

A declining share of BERD in GERD over recent years is a feature that Sweden shares with Norway and to a lesser extent, the United Kingdom (Figure 2.12). However, unlike these two countries, Sweden had a relatively high share to begin with, standing above the OECD average until 2007. The remaining R&D intensive countries examined experienced relative stability over time.

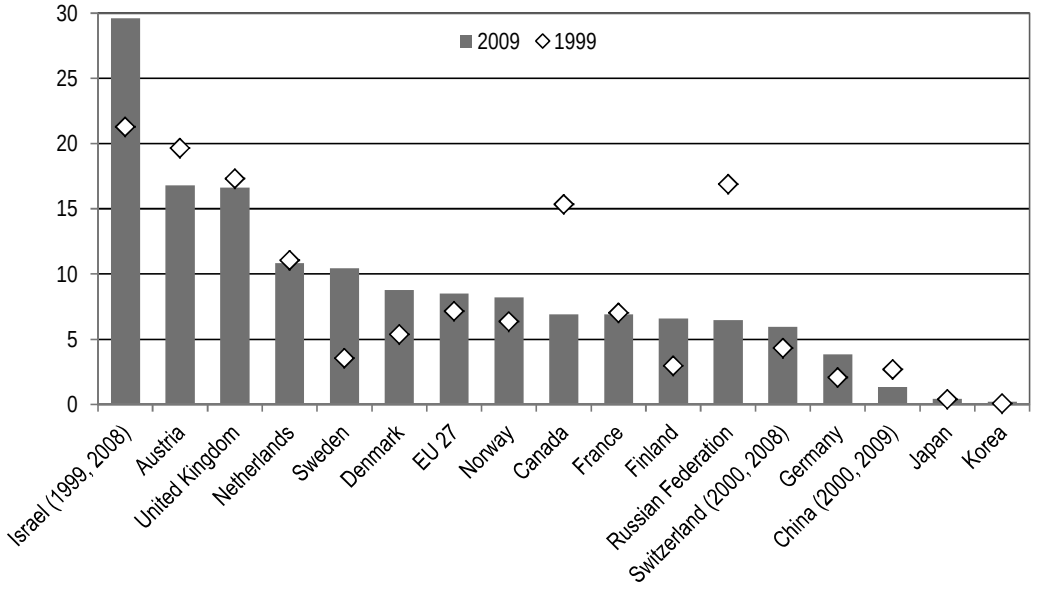
Figure 2.12. Percentage of GERD financed by industry in selected countries, 1995-2009



Source: OECD Main Science and Technology Indicators 2012/1.

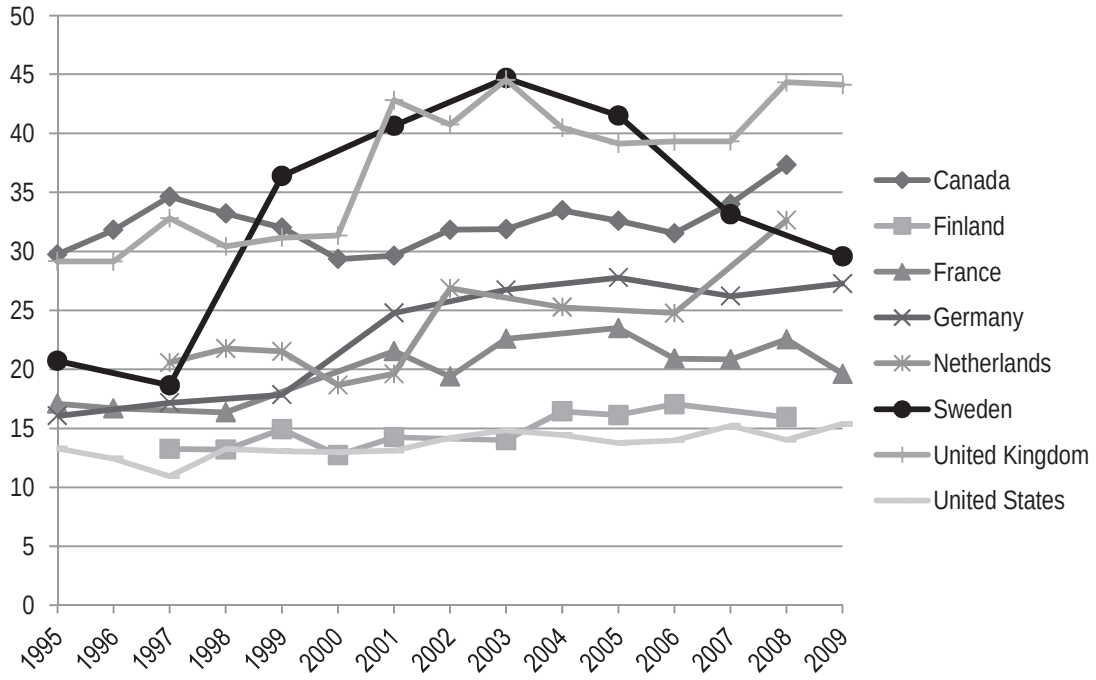
The activities of MNE affiliates in Sweden and participation in European instruments such as the Framework Programme (FP), the European Research Council (ERC) and the European Institute of Innovation and Technology (EIT), as well as the increased emphasis on research and innovation for Structural Funds, mean that the share of GERD financed from abroad has increased in recent years. As Figure 2.13 shows, in 2009 as much as 10.5% of R&D was financed by abroad compared to 3.5% in 1999.

Figure 2.13. Percentage of GERD financed by abroad in selected countries, 2009



Source: OECD Main Science and Technology Indicators 2012/1.

Figure 2.14. R&D expenditure of foreign affiliates as a percentage of R&D expenditures of enterprises in selected countries, 1995-2009



Source: OECD Main Science and Technology Indicators 2012/1.

Table 2.1. GERD by sector of performance and source of funds, USD million PPP Current prices, 2009 (percentages in brackets)

Sector of performance Source of funds	Business enterprise	Government	Higher education	Private non-profit	Total (performance)
Business enterprise	7 176 (82%)	28 (5%)	141 (4%)	0.1 (1%)	7 346 (59%)
Government	518 (6%)	486 (88%)	2,423 (77%)	6 (63%)	3 433 (27%)
Higher education	7 (0%)	4 (1%)	70 (2%)	0 (0%)	81 (1%)
Private non-profit	13 (0%)	13 (2%)	295 (9%)	3 (36%)	325 (3%)
Funds from abroad	1 075 (12%)	23 (4%)	206 (7%)	0.1 (1%)	1,305 (10%)
Total (funding sector)	8 790 (100%)	554 (100%)	3 135 (100%)	9.4 (100%)	12 489 (100%)

Source: OECD Science, Technology and R&D Statistics, 2012.

Sweden is an internationally open economy with many foreign companies actively engaged in R&D. Although the R&D activities of foreign affiliates seem to have decreased from a peak in 2003, Sweden still compares favourably with other OECD economies (Figure 2.14). Insofar as the decline in foreign affiliate R&D expenditure may signal Sweden's lessened attractiveness for knowledge-related investments, it could be a cause for concern, especially since most other countries have experienced stable or increasing trends. However, Sweden's unusually high shares in earlier years were the result of exceptional events and the decline likely reflects a return to more sustainable levels. The pattern observed here corresponds to the unfolding of complex processes linked to globalisation. The observed rise early in the period considered is probably associated with the foreign takeover of a few large R&D performers (see ITPS, 2005, p. 5 with reference, in particular, to the 1995-97 spike) and also with the gradual decline in absolute BERD following the exceptional expansion around 2001. The gradual decline in the share of affiliate expenditure after 2003 probably reflects diversion to other countries and to domestically owned spinoffs. In fact, BERD in domestically owned companies rose substantially from SEK 41.5 million in 2005 to SEK 50 million in 2009 (Tillväxtanalys, 2011, p. 61).

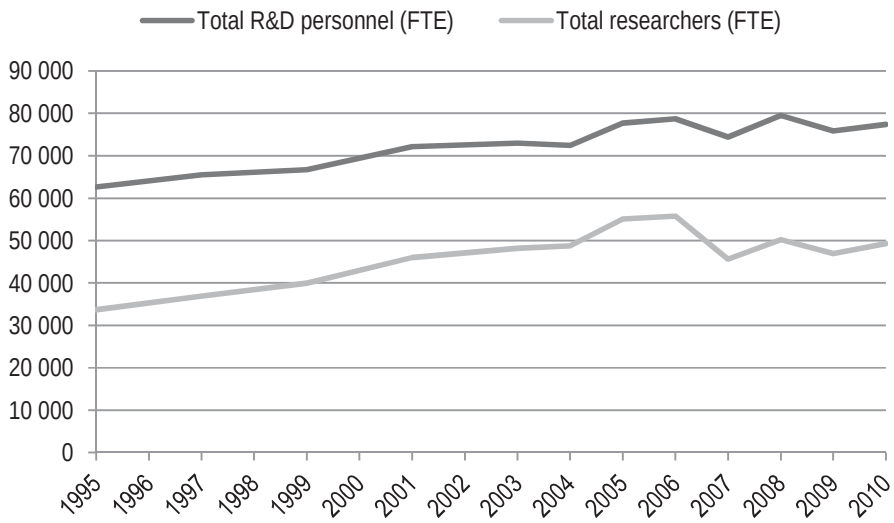
Business is the main performer of GERD, but a reluctant funder of other institutional sectors (Table 2.1). Almost the entirety of business spending on R&D is performed by companies. Out of a total of USD 7.3 billion PPP of business enterprise spending, USD 7.2 billion (97.6%) is directed at business, with the remainder (equivalent to only 2%) going to higher education. Yet business funding of BERD accounts for a much smaller 81.6%, with the rest accounted for by sources from abroad (12%) and government (5.9%). From the point of view of higher education, the financial engagement of Swedish industry is relatively low by international standards, with only 4.5% of total higher education expenditure funded by business enterprises compared to the 6.3% OECD average in 2009 (OECD, 2012).

2.1.3. R&D personnel

R&D personnel include researchers as well as other support staff such as technicians and managers. Trends in the number of R&D personnel provide an alternative view of the scale and nature of R&D activity. As a large proportion of R&D expenditures goes towards the salaries of research personnel, their overall numbers can be expected to correlate closely – if imperfectly – with GERD. Differences in the two trends can in fact be suggestive of a shifting policy focus, either towards the strengthening of human resource capacities or towards the development of infrastructures. More importantly though, there are a number of issues relating to the uninterrupted supply of human resources, to the qualities of their skills and to the manner with which such skills are deployed that cannot be ascertained from expenditure figures alone. This section presents a brief overview of key indicators, which are treated in further detail in section 3.5.

As Figure 2.15 shows, with the exception of minor fluctuations in recent years, the number of R&D personnel and the number of researchers (full-time equivalent, FTE) has grown steadily in Sweden over the last 15 years. Noteworthy is the mild tendency of the two trends to converge (the difference narrows from 29 000 in 1995 to about 23 000 in 2006). Also worth noting is the proportionately greater decline in the number of researchers compared to the number of R&D personnel in 2007, indicative of the varying sensitivity of the employment of the two groups to the contemporary BERD contraction. The last observation may be related to differences in the terms of employment for the two groups, the career stage or institutional sector of employment distribution of the researcher population and/or the propensity of researchers to move.

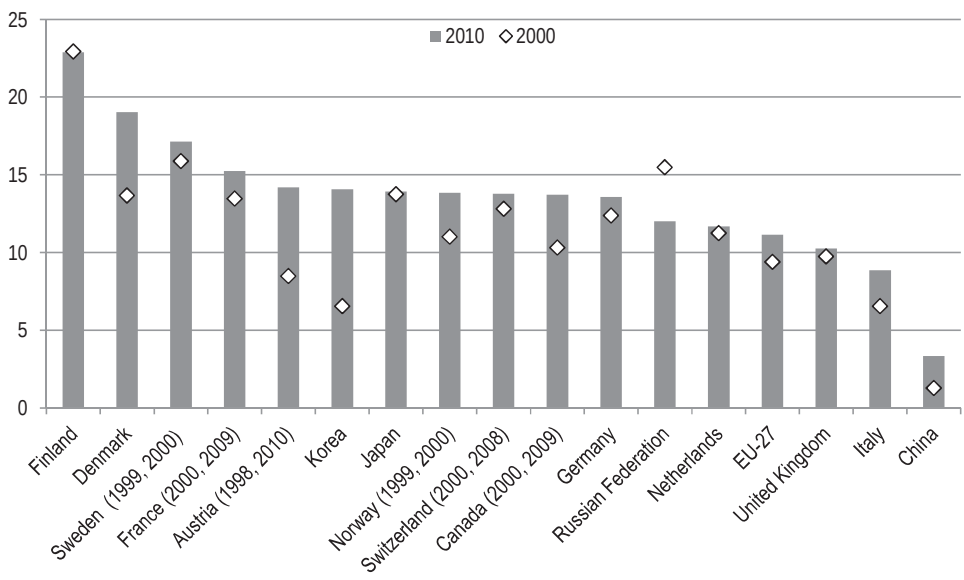
Figure 2.15. R&D personnel and researchers (full-time equivalent) in Sweden, 1995-2010



Source: OECD Main Science and Technology Indicators 2012/1.

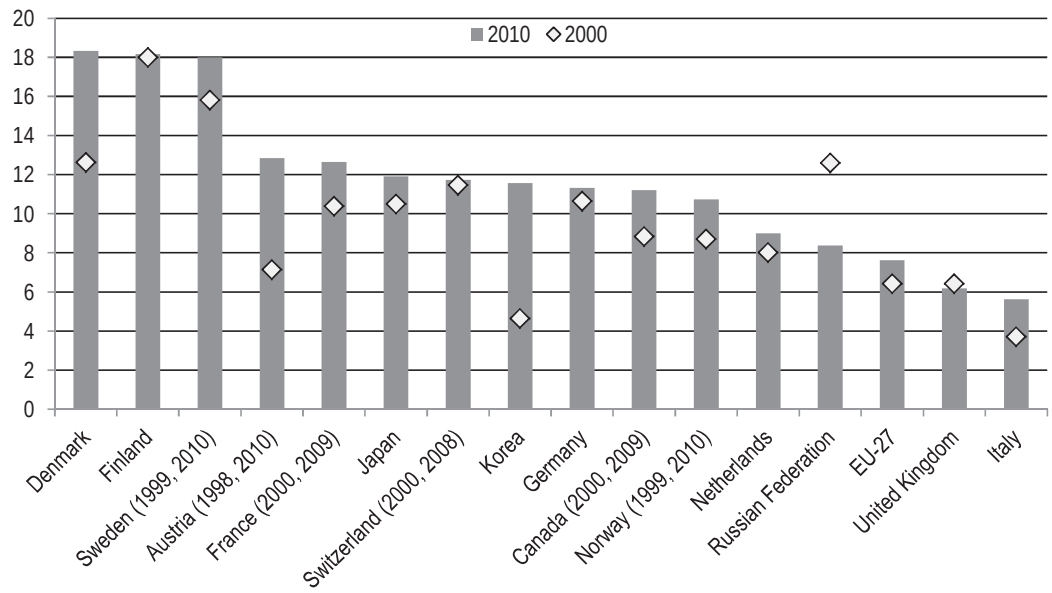
From an international perspective, the number of total R&D personnel and business enterprise R&D personnel (FTE) per thousand total employment is high in Sweden (Figure 2.16 and 2.17), a reflection of the country's high R&D intensity. Indeed, Sweden is above most OECD countries, with only Finland, and Denmark having higher rates. On both indicators, but particularly in terms of business enterprise R&D personnel, Sweden has experienced growth over time, which contrasts with the slightly negative change in R&D intensity.

Figure 2.16. Total R&D personnel (FTE) per thousand total employment in selected countries, 2000 and 2010



Source: OECD Main Science and Technology Indicators 2012/1.

Figure 2.17. Business enterprise R&D personnel (FTE) per thousand employment in industry, 2000 and 2010



Source: OECD Main Science and Technology Indicators 2012/1.

2.2. Innovation outputs

The measurement of innovation outputs is challenging for a number of reasons. First, available indicators only partially cover the many facets of innovation, so that a comprehensive assessment is not possible. While aspects of technological innovation and increments to scientific knowledge are well covered, it is difficult to assess the extent of process, organisational and marketing innovation, which is especially important for the services sector. Second, with the exception of indicators from innovation surveys, innovation indicators draw on data (such as patents and bibliometrics) originally collected for a different purpose and are therefore subject to influences that may not correspond to innovation. Third, as no two innovations are alike, the impact of innovation differs wildly for every discrete increment of innovation output. Attempts to remedy this with indicators that gauge the impact of innovation on the economy only partly address the issue. Such limitations mean that the view obtained by aggregate indicators is inevitably partial and underline the need for long temporal and broad country coverage as well as independent corroboration where possible. Nevertheless, taken together, the various available indicators of innovation present an opportunity to evaluate output systematically in a way that is consistent across countries and over time.

2.2.1. Firm-level innovation

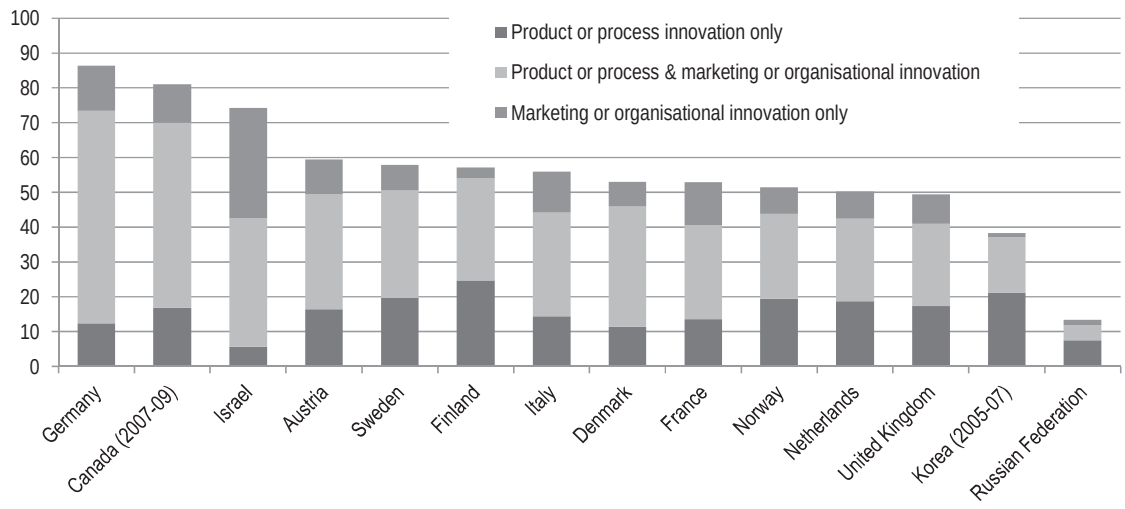
According to the EU Community Innovation Survey (CIS) covering 2006-08, 54% of Swedish companies were engaged in some type of innovation activity (product, process, organisational or marketing). Sweden's percentage is slightly above the EU average (52%) and indeed that of most other European countries, except Germany, with an exceptional 80% of all firms.

Figure 2.18 presents the share of manufacturing firms engaged in innovation activity, broken down into three categories according to the types of innovation pursued: *i)* product and process innovation only; *ii)* all four types of innovation; *iii)* marketing or organisational innovation only. Overall, 57.9% of all manufacturing firms in Sweden engaged in innovation. A relatively high proportion pursued all four types of innovation (30.8%). Relative to other countries in the comparator group, Sweden is fourth in this category behind Germany, which leads the comparator group with 61%. Still, Sweden's relatively high share indicates that firms recognise the presence of opportunities for innovation irrespective of the type of innovation. It may also reflect the preponderance of large firms, with a preference for encompassing various stages of production. A smaller 19% of Swedish manufacturing firms pursue product or process innovation only and an even smaller 7.3% pursue marketing or organisational innovation only. Although such a share is small compared to countries such as Israel (31.7%), Canada (11.1%), Germany (12.9%) and France (12.4%) it is still higher than that of Finland (3%) and about on a par with Denmark (7.1%) and Norway (7.6%). It is likely that, to some extent, the latter shares reflect Sweden's sectoral specialisation.

Figure 2.19 presents the share of services firms engaged in innovation activity, broken down into the three categories outlined above. There is generally less innovation in the services sector than in manufacturing. At 50.8%, it is lower than in Germany, Canada, Israel, Austria and Denmark. In both manufacturing and services higher shares of firms perform all four types of innovation; among Swedish services companies 28.1% pursued all types. As one would expect, a larger proportion of services companies than manufacturing companies (10.1% *vs.* 7.3%) pursued marketing or organisational innovation only. However, the overall pattern is similar in both sectors.

Figure 2.18. Innovation in the manufacturing sector by company category for selected countries, 2006-08

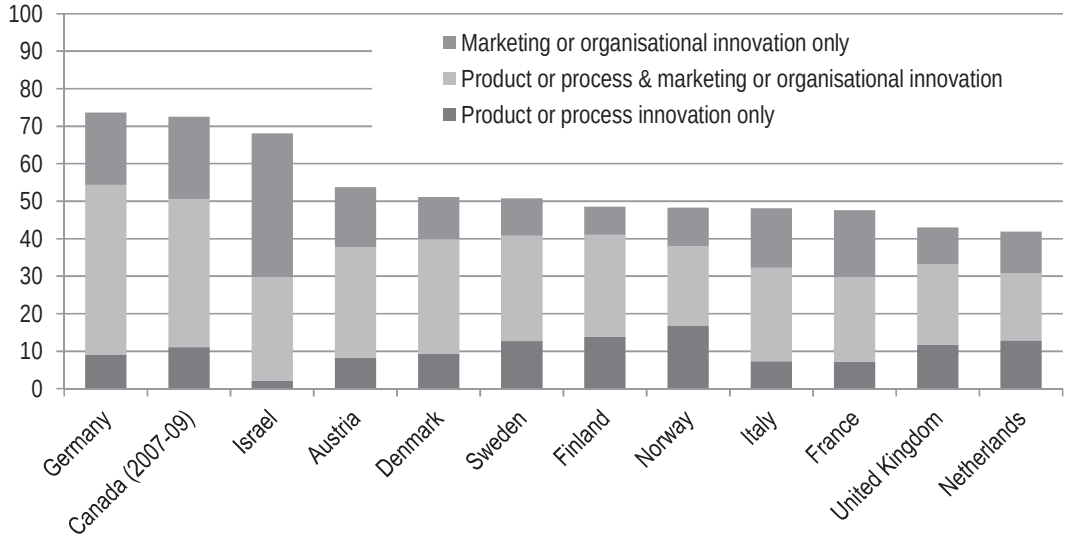
As a percentage of all manufacturing firms



Source: OECD Science, Technology and Industry Scoreboard 2011, p. 141.

Figure 2.19. Innovation in the services sector by company category for selected countries, 2006-08

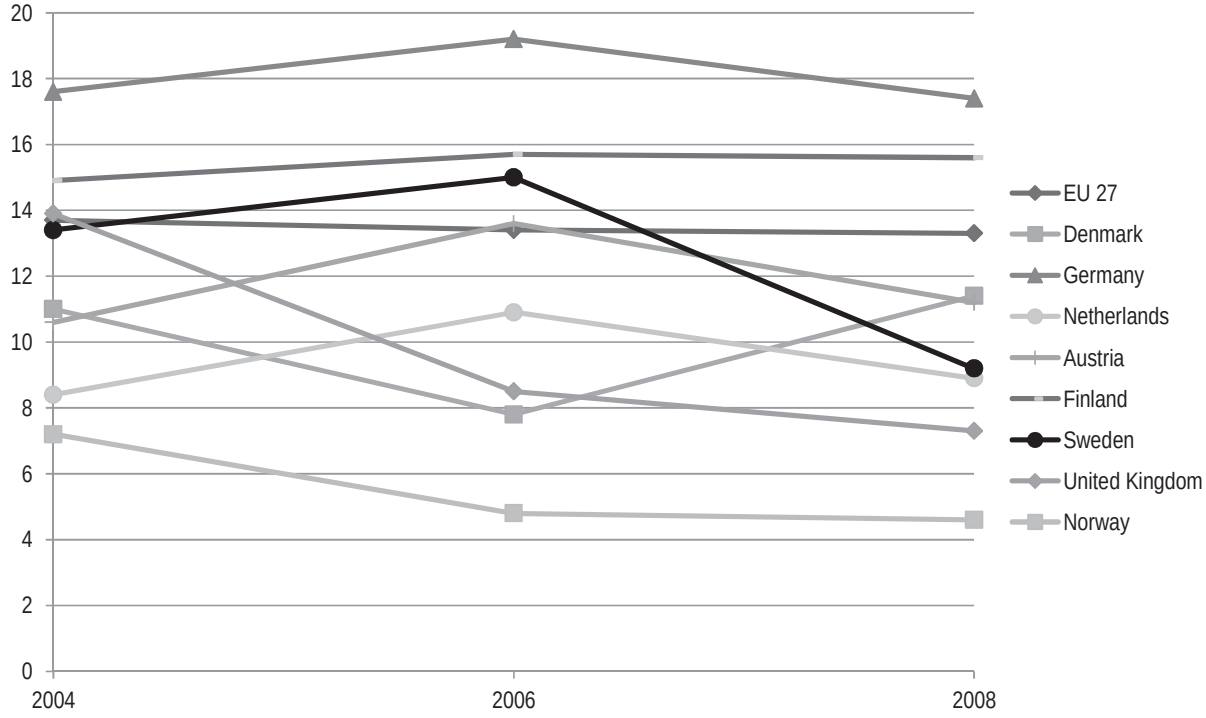
As a percentage of all services firms



Source: OECD Science, Technology and Industry Scoreboard 2011, p. 141.

Figure 2.20. Turnover from innovation: The ratio of turnover from products new to the enterprise and new to the market, 2004-08

As a % of total turnover for selected countries



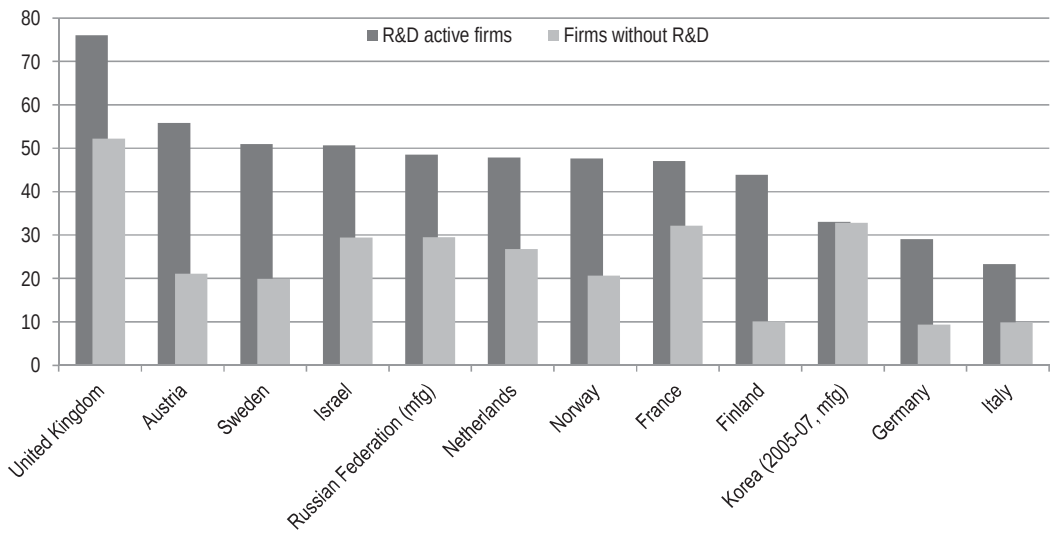
Source: Eurostat (2012) based on Community Innovation Surveys of European Union.

Figure 2.20 shows the share of innovation-related turnover as a percentage of total turnover across three waves of the CIS in 2004, 2006 and 2008. In keeping with the amount of innovation expenditure per company (Figure 2.1), Sweden was among the leaders in the share of innovation-related turnover in 2004 and 2006. In 2008, however, Sweden's share experienced the sharpest decrease among the countries considered, falling from 15% to 9%. As most countries experienced a decrease in that year it is likely that the drop reflects the effects of the financial crisis on demand for innovation-related goods and services.

From a company perspective, collaboration opens avenues for knowledge sharing and R&D productivity gains but may also imply costs, such as direct costs for services rendered or the obligation of shared ownership, the risk of knowledge spillovers and the opportunity costs involved in co-ordination. Therefore an at least implicit weighing of the potential benefits to be derived from gaining access to the skills and experience of collaborators against the potential costs largely determines whether companies choose to collaborate. In turn the evaluation of such benefits and costs may depend on the efficiency of communication channels and the presence of dependable framework conditions (including a strong intellectual property rights regime). Evidence on rates of collaboration can be a revealing measure of the presence of these conditions. Collaboration can be part of the innovation process irrespective of whether firms perform R&D, as it applies to effective assimilation of existing technology, to product development and marketing.

Figure 2.21. Firms engaged in collaboration on innovation by R&D status, selected countries, 2006-08

As a percentage of R&D active and R&D non active firms.



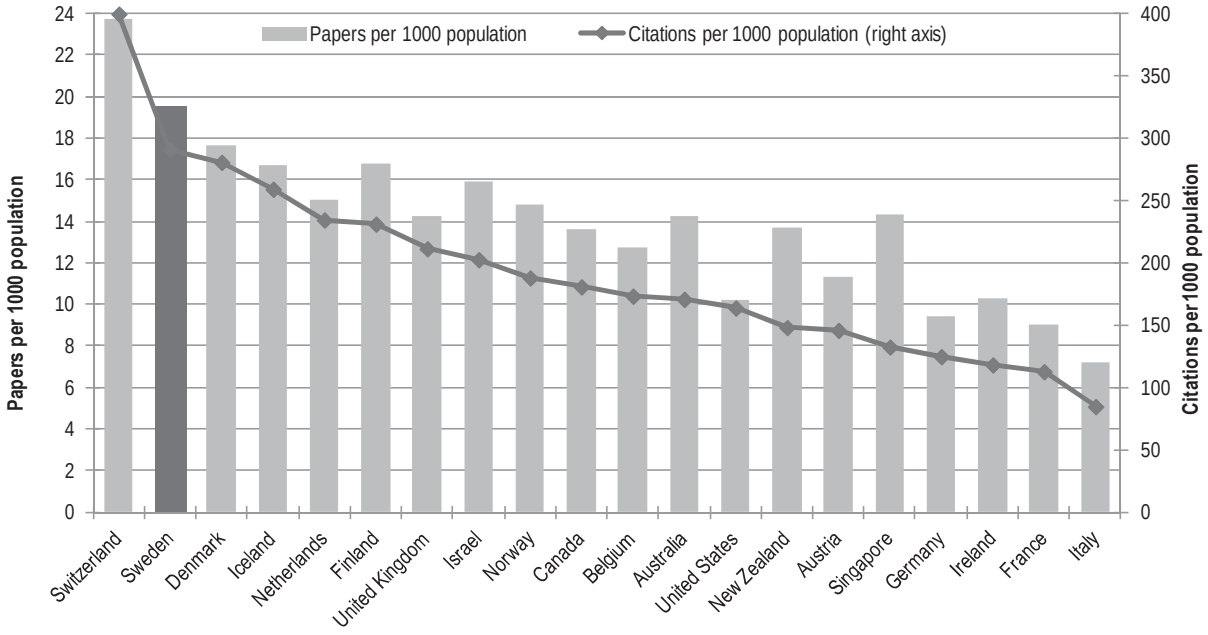
Source: OECD Science, Technology and Industry Scoreboard 2011, p. 142 (mfg refers to manufacturing).

Figure 2.21 presents CIS evidence on the share of R&D and non-R&D performing firms that engage in collaboration. In all countries, R&D-active firms tend to collaborate more than non-active firms, and 51% of R&D-active firms in Sweden were engaged in collaboration on innovation between 2006 and 2008, which compares favourably with selected countries. This contrasts with firms without R&D, only 20% of which collaborated. Sweden's share is relatively low by international standards and may reflect bottlenecks in the system.

2.2.2. Scientific publications

Sweden is among the global leaders in science, in terms both of output and of quality. Scientific output, measured by the number of scientific articles per 1 000 persons, places Sweden second only to Switzerland and the same is true for citations (Figure 2.22). There are also indications that the impact of Swedish scientific research is greater than would be expected for a country of its size. For one, while Sweden accounts for 1.4% of global scientific papers, it accounts for a comparatively larger 1.8% of the global number of citations (Table 2.1). The relative impact factor of Swedish scientific publications is strong, with the average Swedish paper cited about 15 times, though Switzerland, the United States, Denmark, the Netherlands and Israel are stronger. Sweden also performs well in terms of the number of highly cited researchers (HCR) with 7 per million population, a figure only lower than those of the United States and Switzerland.

Figure 2.22. Intensity of scientific output and impact, selected countries, 2000-10



Source: BMWF, BMVIT, BMWFJ (2011), *Austrian Research and Technology Report 2011*, based on ISI, calculations by Johanneum Research.

Table 2.2. Bibliometric data of the top 20 countries (ranked by citations per 1 000 population), 2000-10

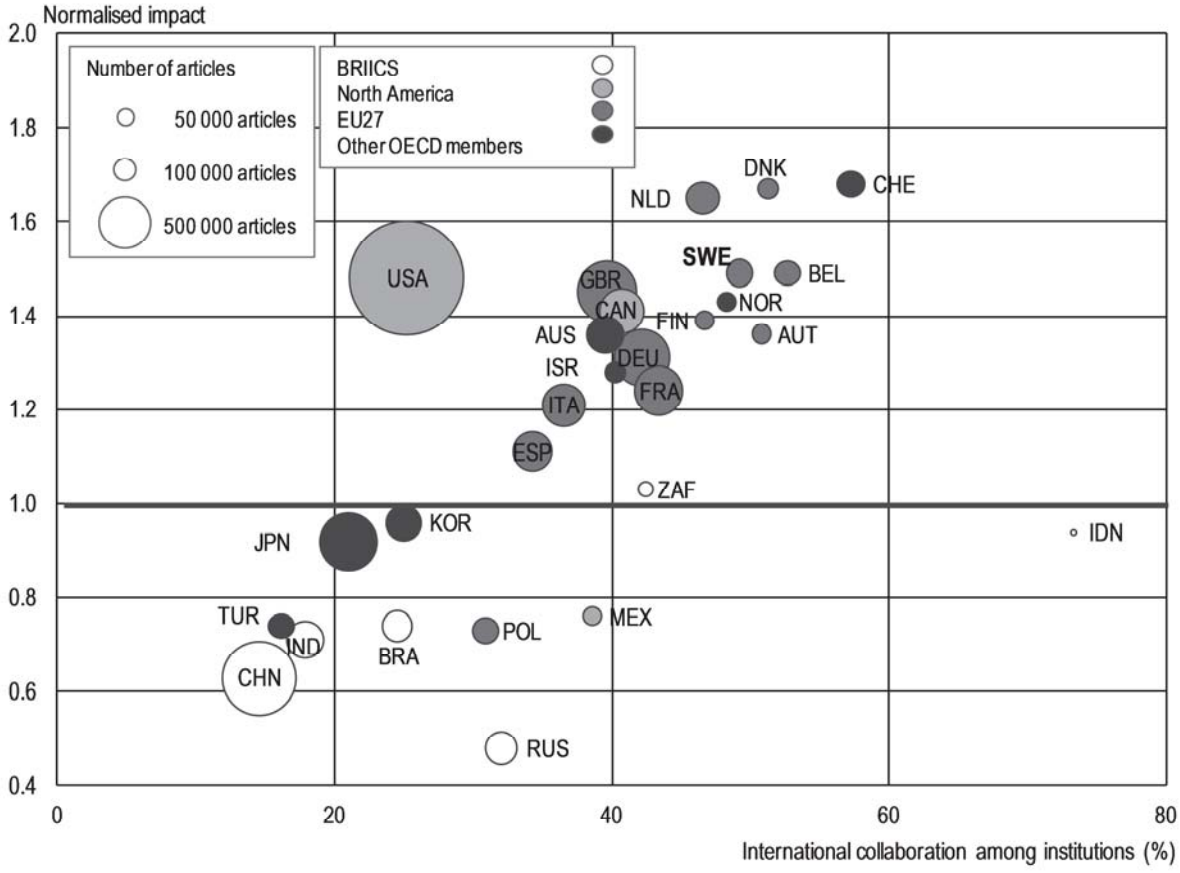
Country	Papers (thousands)	Citations (thousands)	Population (millions) (2000-09)	World share papers %	World share citations %	Citation per paper	Papers per 1 000 population	Citations per 1 000 population	2 yr citation growth %	ISI HCR	HCR per million population
CHE	176	2 970	7	1.4	2.0	16.9	23.7	399.8	11.5	115	15.5
SWE	**177**	**2 632**	**9**	**1.4**	**1.8**	**14.9**	**19.6**	**291.0**	**11.3**	**65**	**7.2**
DNK	95	1 521	5	0.8	1.0	15.9	17.6	280.8	11.7	31	5.7
ISL	5	77	0	0.0	0.1	15.5	16.7	259.2	13.3	0	0.0
NLD	244	3 813	16	2.0	2.6	15.6	15.0	234.4	11.8	105	6.5
FIN	88	1 213	5	0.7	0.8	13.8	16.8	231.2	11.4	20	3.8
GBR	853	12 648	60	7.0	8.7	14.8	14.3	211.4	11.4	115	1.9
ISR	110	1 407	7	0.9	1.0	12.7	15.9	202.7	11.3	50	7.2
NOR	69	870	5	0.6	0.6	12.7	14.8	188.0	12.2	14	3.0
CAN	439	5 814	32	3.6	4.0	13.2	13.7	180.9	11.7	196	6.1
BEL	133	1 817	10	1.1	1.2	13.7	12.7	173.4	12.1	39	3.7
AUS	290	3 482	20	2.4	2.4	12.0	14.2	170.8	12.1	122	6.0
USA	3 018	48 299	295	24.6	33.1	16.0	10.2	164.0	11.1	4 143	14.1
NZL	56	607	4	0.5	0.4	10.8	13.7	148.3	12.0	20	4.9
AUT	93	1 198	8	0.8	0.8	12.9	11.3	146.0	11.9	20	2.4
SGP	62	570	4	0.5	0.4	9.3	14.3	132.6	14.7	4	0.9
DEU	776	10 277	82	6.3	7.0	13.2	9.4	124.9	11.4	262	3.2
IRL	43	488	4	0.3	0.3	11.5	10.3	118.3	12.5	8	1.9
FRA	551	6 875	61	4.5	4.7	12.5	9.1	112.9	11.3	166	2.7
ITA	417	4 930	58	3.4	3.4	11.8	7.2	84.8	11.8	85	1.5

Source: FWF, 2010, p. 76 and ISI database 7/2011.

However, Sweden's performance appears less strong when one considers the internal quality distribution of publications. The percentage of national publications accounting for the top 10% of citations can be a useful indicator in this regard.[2] According to the EC (2011), in 2007 Sweden's contribution to the 10% most cited scientific publications as share of total national publications was in the range of 12.3-15.3%. While this confirms that the quality of the research in the Swedish system and internationally is considerably above average, Sweden's share was behind those of Denmark, the Netherlands, Belgium, Iceland, Switzerland and the United States.

Collaboration and impact are interdependent: increased international collaboration exposes national scientific endeavours to a wider audience and enhances its impact, while greater impact enhances attractiveness as a collaboration partner. This positive relationship can be observed across countries in Figure 2.23. Sweden scores considerably above average on both counts. As for other countries, its impact is proportional to its degree of international collaboration. The United States and, to a lesser extent, the United Kingdom, are the only countries with a greater impact than would be expected from their degree of international collaboration.

Figure 2.23. The impact of scientific production and the extent of international scientific collaboration, 2003-09



Source: OECD Science, Technology and Industry Scoreboard 2011.

2.2.3. Patents

International patenting can be a useful measure of the production of economically valuable technology, which is especially relevant for developed innovation systems with a strong manufacturing sector. Sweden's long tradition in technological innovation and its diverse range of large R&D-intensive companies is reflected in its strong performance in international patenting.

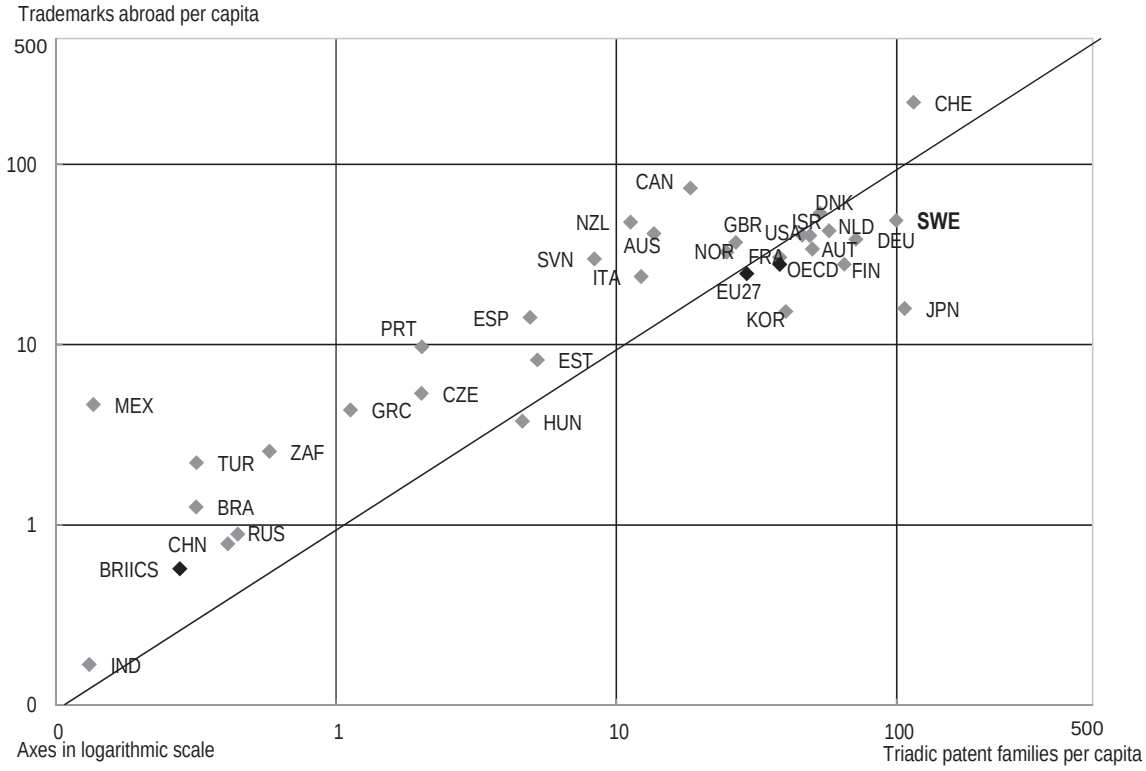
One measure of international patenting is the number of triadic patent families, defined as patents applied for at the European Patent Office (EPO), the Japan Patent Office (JPO) and the US Patent and Trademark Office (USPTO) referring to the same invention. Triadic patents are typically of higher value and lessen biases introduced by the geographical coverage of individual patenting offices. The indicator of trademarks abroad is similar in construction, corresponding to the number of applications filed at the USPTO, EU and the JPO.

Figure 2.24 plots country scores against the two indicators, converted to logarithms to permit comparisons across systems of vastly different magnitudes. Sweden is among the leaders with respect to both triadic patents and international trademarks. In terms of triadic patents per capita in particular, Sweden is among the world's three most prolific countries, a position that emphasises the strength of its technological capacities.

It is interesting to see that the country observations in Figure 2.24 are arranged in an orderly way around a positive diagonal line. Companies in countries positioned exactly on the diagonal can be said to have an equal propensity to file for a trademark as opposed to apply for a patent. Countries positioned in the lower half of the figure are, with the exception of Hungary, above the diagonal; this indicates a greater propensity to file for trademarks rather than patents. In contrast, a majority of countries positioned in the upper half of the figure on both counts (including the OECD and EU27 averages) are below the diagonal. Sweden belongs to this latter group of countries, with only Japan and Korea showing a greater propensity to patent.

Figure 2.24. Patent and trademarks per capita, 2007-2009

Average number per million population, OECD and G20 countries



Source: OECD Science, Technology and Industry Scoreboard 2011.

Sweden is one of the leading EU countries in patent applications per million population and is above the EU average by a significant margin (383.4 applications per millions compared to 132.1 per million in 2011) (Table 2.3). The number of applications increased by about a third in both Sweden and the EU between 2002 and 2011. In Sweden as in the rest of the EU, the number of patent applications decreased in 2009 before rebounding to above pre-crisis levels in 2010.

Table 2.3. European patent applications to the EPO per million population, 2002-11

	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Sweden	286.1	290.1	277.1	278.3	281.7	302.7	343.9	340.6	381.9	383.4
EU27	106.0	114.7	119.1	122.8	125.6	129.6	135.3	127.7	136.8	132.1

Source: EPO (2012a), *www.epo.org/about-us/statistics/patent-applications.html* and Eurostat (2012)

A sectoral breakdown of patenting activitiy reveals the sources of Sweden's technological strength. EPO statistics list 35 technological subfields in chemistry, electrical engineering, instruments, mechanical engineering and other fields. Table 2.4 shows that Sweden applies to the EPO in many fields, with the top ten fields representing only 64% of total applications, the sign of a diverse range of technological capabilities. Digital communication, telecommunications and medical technology are the most active sectors followed by transport, an area in which Swedish industry has a history of strong presence.

Table 2.4. European patent applications filed with the EPO, 2002-11, total and top ten fields

	Field of technology*	2002-11 total	Share
1	Digital communication	3 935	13.6
2	Telecommunications	3 228	11.2
3	Medical technology	2 102	7.3
4	Transport	1 812	6.3
5	Organic fine chemistry	1 714	5.9
6	Computer technology	1 556	5.4
7	Mechanical elements	1 117	3.9
8	Civil engineering	1 108	3.8
9	Measurement	1 050	3.6
10	Pharmaceuticals	972	3.4
	Subtotal	18 594	64.4
	Total	28 878	100.0

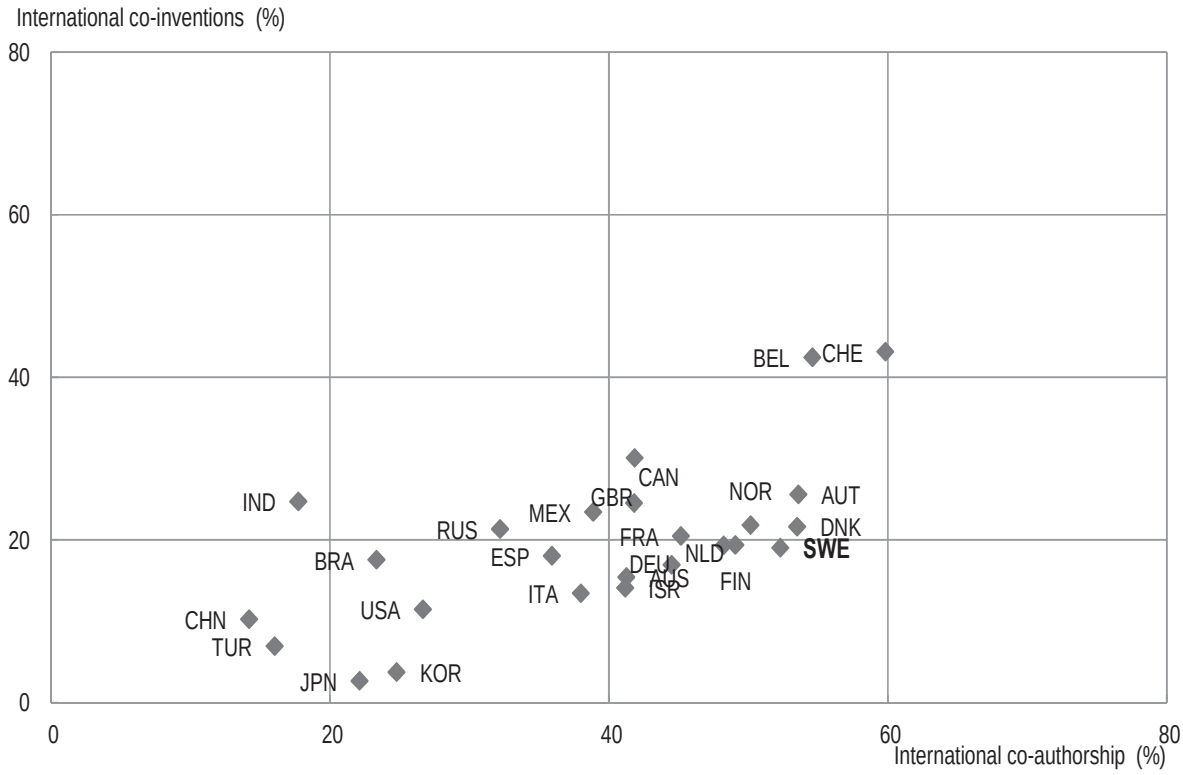
Source: EPO (2012b).

International collaboration in technology can be an important channel for technology transfer. However, observed trends in international collaboration are the result of rather complex processes, which precludes straightforward interpretation. International co-patenting in particular may signal both arm's-length collaboration and within-firm activities across national jurisdictions. On the one hand, high rates of international collaboration may reflect functional similarity which permits integration into international knowledge production chains, of the ownership and location regimes of multinational affiliates, and may also be affected by geographical proximity to major centres of technology production (Maggioni and Uberti, 2009). On the other hand, national systems that are large enough to contain entire knowledge production chains and capacities across a wide range of technological areas are less likely to engage in international collaboration.

Figure 2.25 presents international collaboration rates in patenting (co-inventions) and publications (co-authorship). Countries that co-invent tend also to co-author internationally. This suggests that international collaboration in these two very distinct knowledge production settings is at least partly driven by common factors. In Sweden a high 55% of scientific articles are produced with international co-authorship, while only 19% of PCT patent applications are produced with international collaboration, below the OECD average. While this may reflect, in part, the large average firm size in Sweden, it is also likely that the benefits from internationalisation in the technology sector have yet to be fully harnessed. Indeed, the fact that Switzerland is much closer to the notional line of equal propensity to co-invent and to co-author suggests that there is room for improvement.

Figure 2.25. International collaboration in science and innovation, 2007-09

Co-authorship and co-invention as a percentage of scientific publications and PCT patent applications



Note: International co-authorship of scientific publications is based on the share of articles with authors affiliated with foreign institutions in total articles produced by domestic institutions. Co-inventions are measured as the share of patent applications with at least one co-inventor located abroad in total patents invented domestically.

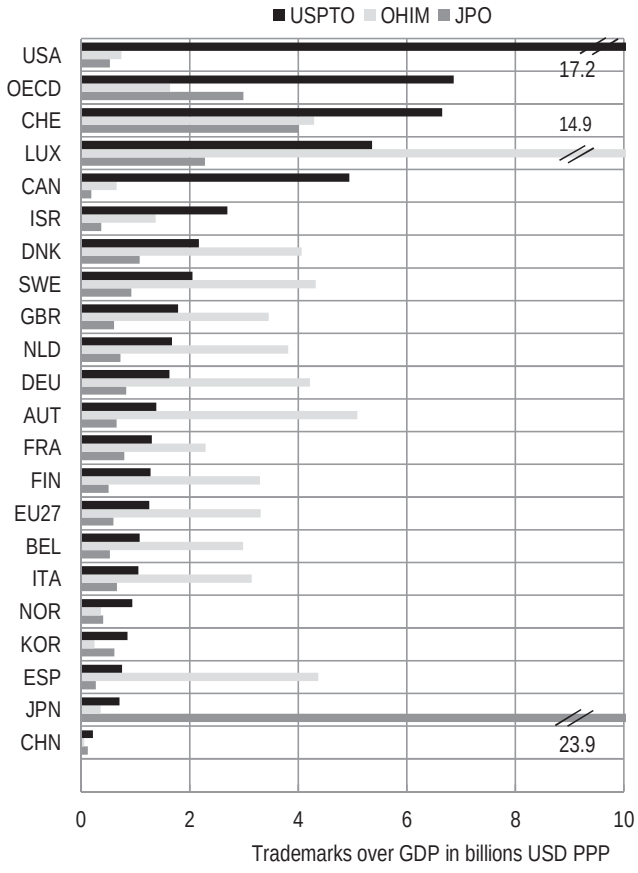
Source: OECD Science, Technology and Industry Scoreboard 2011, p. 48.

2.2.4. Trademarks

Trademarks are meant to protect a firm's distinctive sign and other aspects of its brand. Like patents, trademark applications may signify the generation of economically useful novelty and may therefore be used as a complementary indicator of innovation. As an indicator of innovation, trademarks are especially relevant to the services sector and, compared to patents, are more representative of the activities of smaller firms and of non-technological innovation in general. Moreover, trademarks correlate well with other innovation indicators (Millot, 2009) as well as with firms' market value (Sandner and Block, 2011) and are a proxy for activity that is closer to the commercialisation stage of innovation (Mendoça *et al.*, 2004).

Figure 2.26 presents a ratio of trademark applications in three major intellectual property offices (JPO, OHIM and USPTO) to GDP. Sweden is among the leading producers of trademarks in the OHIM, similar to Spain, Switzerland, Germany and Denmark, but behind the leader, Austria. Sweden occupies an above-average position in the USPTO, and is, outside of North America, behind Switzerland, Luxembourg, Israel and Denmark. While Sweden is much less likely to file for trademarks at the JPO, if one excludes Japan, its rate is very close to the comparator group average.

Figure 2.26. Trademark applications at JPO, OHIM and USPTO relative to GDP, 2007-09 average

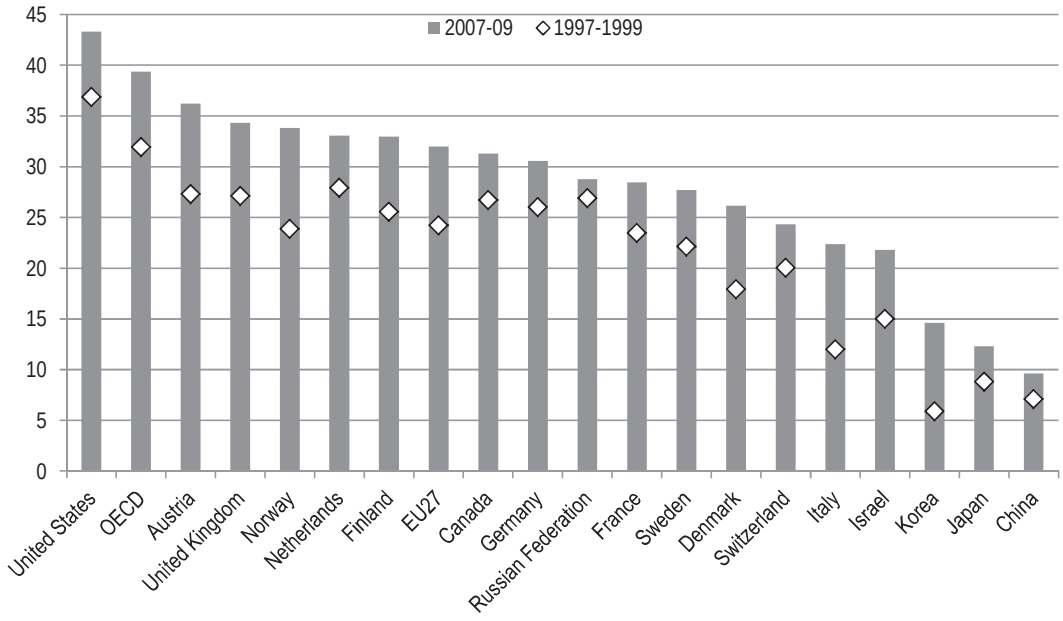


Source: OECD Science, Technology and Industry Scoreboard 2011.

Figure 2.27 presents the share of trademarks in service-sector classes[3] over total trademarks in two periods a decade apart (1997-99 and 2007-09). Service-related trademarks increased in importance in Sweden over the decade in question, rising from 22.1% to 27.7%. This is still below the EU average of 32% and may indicate a weakness in services-related innovation in Sweden.

Figure 2.27. Service-related trademark applications at USPTO and OHIM for selected countries, 1997-99 and 2007-09

As a percentage of total trademark applications at OHIM and USPTO

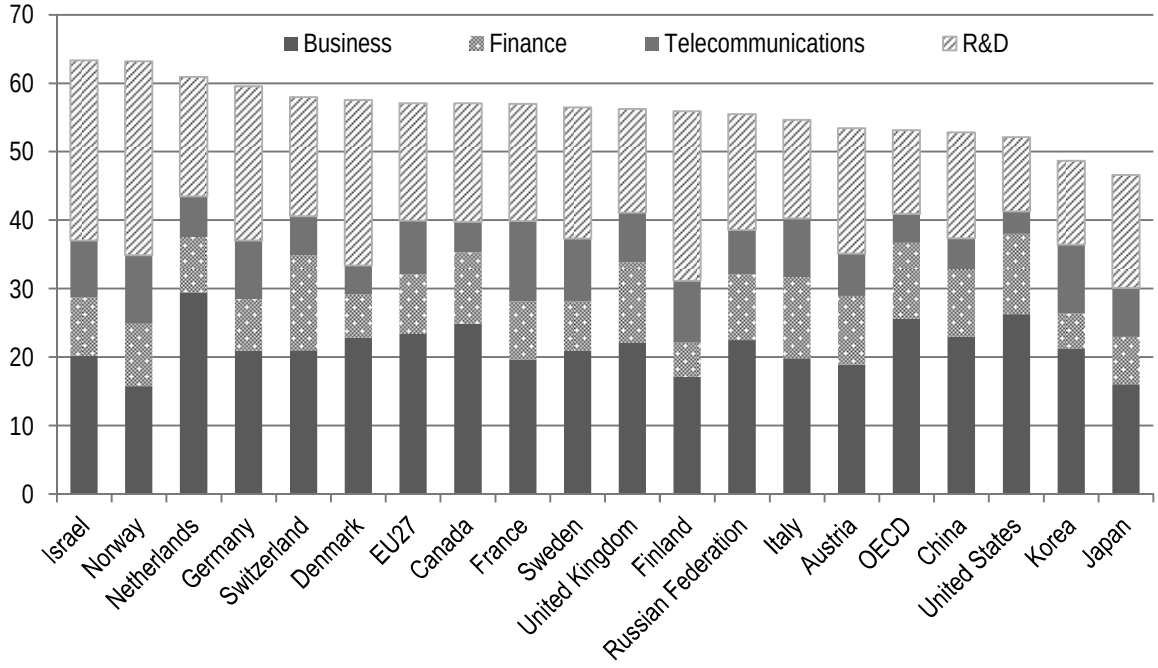


Source: OECD Science, Technology and Industry Scoreboard 2011, p. 44, based on US Patent and Trademark Office (2011), "The USPTO Trademark Casefile Dataset (1884-2010)"; OHIM (European Union) Community Trademark Database; CTM Download, April 2011.

Figure 2.28 shows trademark classes classified as pertaining to "knowledge-intensive services"[4] as a percentage of total trademarks in service-sector classes and offers a breakdown by type of service (business, finance, telecommunications or R&D). As Figure 2.28 shows, the highest percentage of trademarks in knowledge-intensive services is in the business class (21%) followed by R&D (19%). Both finance and telecommunications make up a much smaller proportion of service-related trademarks. Altogether, 56% of Sweden's service-related trademarks are in knowledge-intensive services, a share that is below the EU average.

Figure 2.28. Trademarks in knowledge-intensive services for selected countries, 2007-09

As a percentage of total service-related trademarks



Source: OECD Science, Technology and Industry Scoreboard 2011, p. 44, based on US Patent and Trademark Office (2011), "The USPTO Trademark Casefile Dataset (1884-2010)"; OHIM (European Union) Community Trademark Database; CTM Download, April 2011.

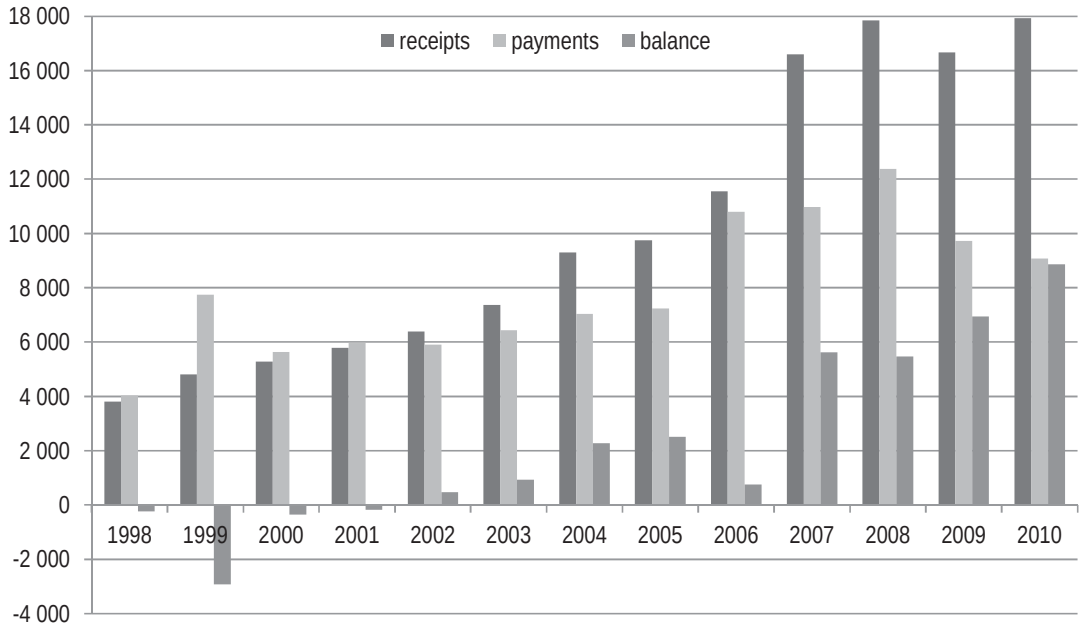
2.2.5. Impact of innovation

Innovation is seldom an end itself, but rather a means towards other ends such as increased profits, productivity, market shares, revenue or aggregate economic growth. The impact of innovation in terms of bringing about economically relevant outcomes is therefore a key aspect of an assessment of a national innovation system. Unfortunately, few measures of impact are readily available and the ones that exist are still partial in their coverage. Traditionally, they have included income from royalty and licence fees as well as the technology balance of payments (TBP). As relatively few patents generate much income and the link between R&D expenditures and high-technology exports is, at best, indirect, these two indicators only provide a “tip of the iceberg” assessment of the economic value of a country’s technological production. The picture can be complemented by trade indicators on R&D-intensive sectors. Moreover, international patent databases have recently made available other promising indicators of impact, drawn from patent citations.

The technology balance of payments corresponds to transactions related to international technology transfer. It consists of money paid or received for the acquisition and use of patents, licences, trademarks, designs, know-how and related technical services (including technical assistance) and for industrial R&D carried out abroad (OECD, 2012). TBP can be a good proxy of the market value of a country’s stock of technology and of the presence of a framework amenable to its appropriation.

For Sweden, TBP data show a rapid increase in receipts in recent years along with a slower increase in payments, which results in a positive and growing net balance in recent years (Figure 2.29). In 2010, Sweden exported around USD 18 billion of technology, while the imports were almost half that figure. The positive net balance trend is a testament to the ability of the Swedish innovation system to produce economically useful innovations.

Figure 2.29. Technology payments, receipts and balance of payments, million current dollars, 1998-2010

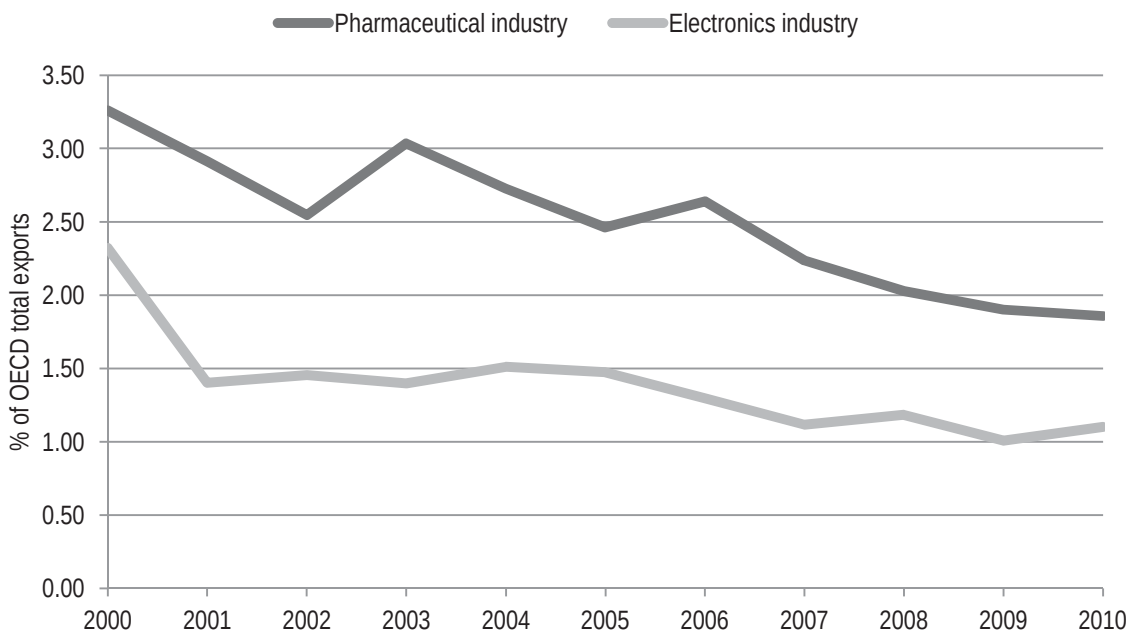


Source: OECD Main Science and Technology Indicators 2012/1.

In addition to conventional innovation output indicators, international trade data may also be useful for analysing the impact of Swedish innovation, especially for sectors in which BERD is important.

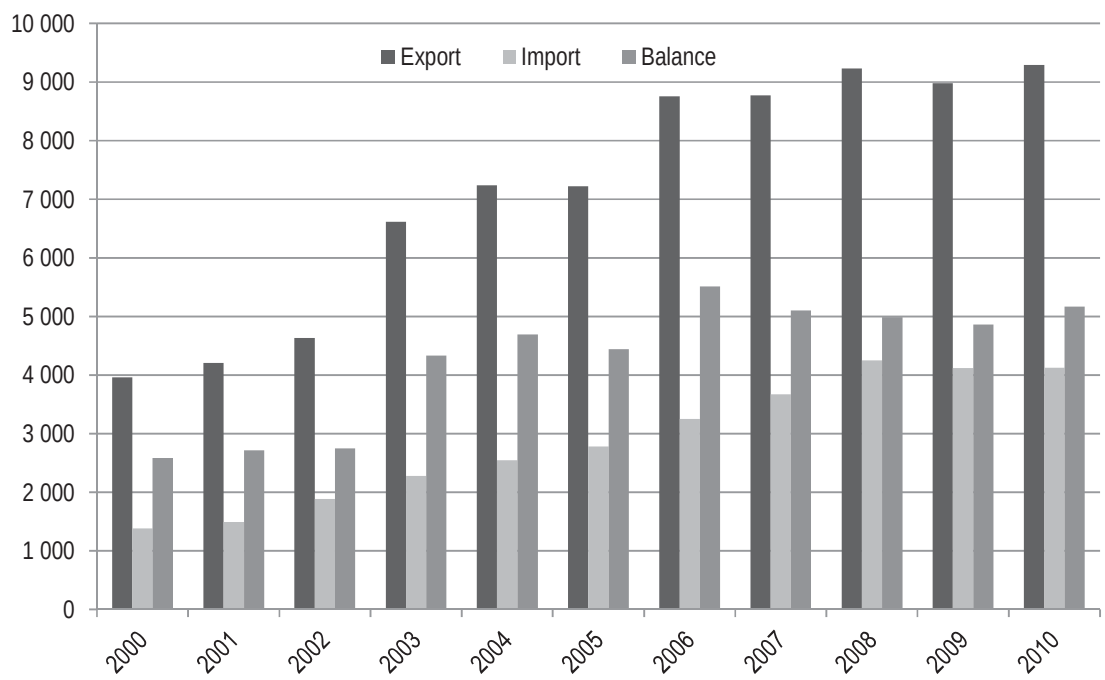
Figure 2.30 presents Sweden's share of total OECD country exports in pharmaceuticals (ISIC 2423) and electronics (ISIC 32). While the moderately negative trend in pharmaceuticals conveys an impression of gradual decline, it is not consistent enough to draw a clear conclusion. In fact, given that the sharpest decline occurred in the period corresponding to the financial crisis, the most appropriate interpretation seems to be long-term stability. Such an interpretation is supported by the stability seen in Figure 2.31 in terms of the net balance of technological payments in the pharmaceutical sector. The picture is different for the electronic industry, a sector in which Sweden has been traditionally strong. Export market share has deteriorated considerably since 2000, as has the trade balance, with a considerable increase in imports (Figure 2.32). However, such a development is probably not negative. A shift of activities in large Swedish firms towards sectors other than electronics (*e.g.* higher value added services) may partly account for this trend.

Figure 2.30. Sweden's share of total OECD exports in pharmaceuticals (ISIC 2423) and electronics (ISIC 32), 2000-10



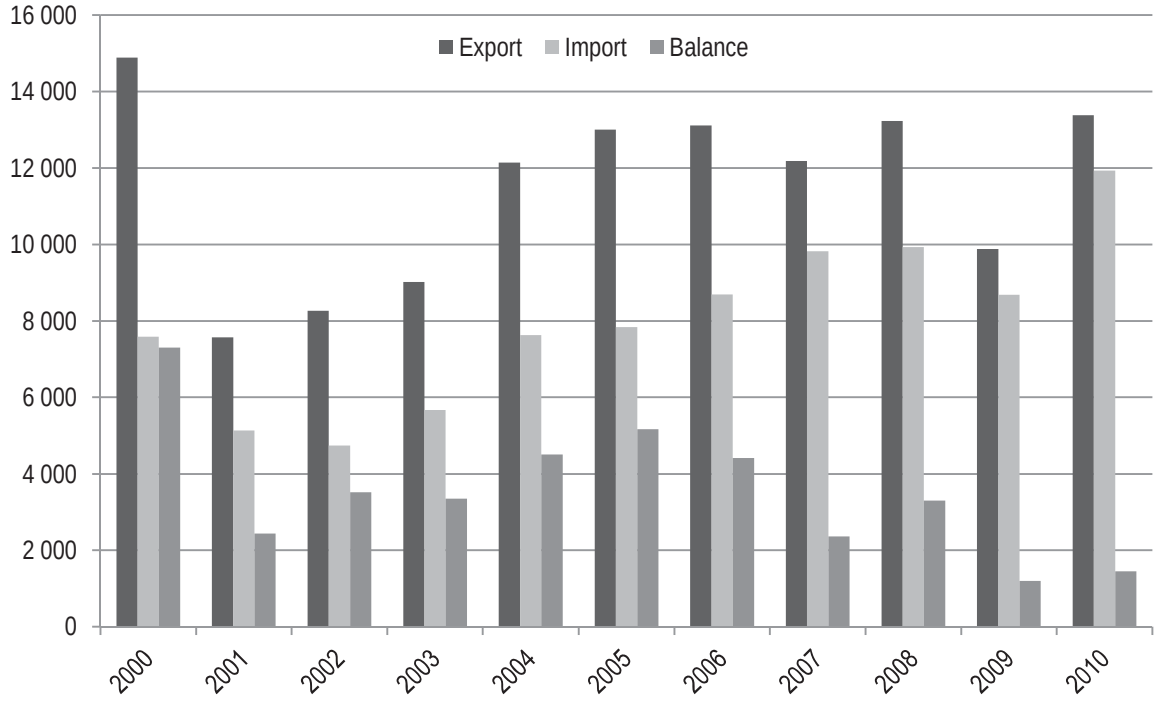
Source: OECD Main Science and Technology Indicators 2012/1.

Figure 2.31. Trade balance of pharmaceuticals, million current USD, 2000-09



Source: OECD Main Science and Technology Indicators 2012/1.

Figure 2.32. Trade balance of electronics industry, million current USD, 2000-09

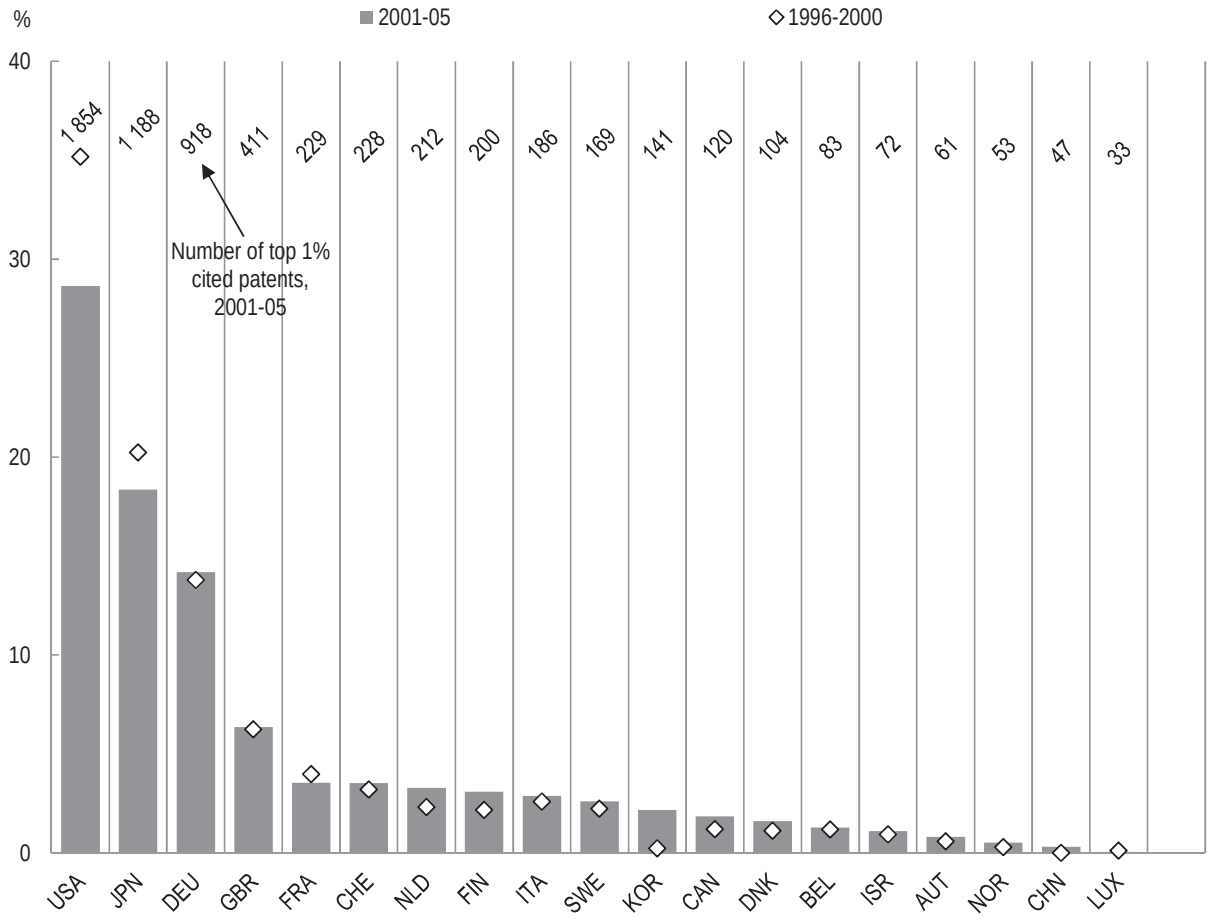


Source: OECD Main Science and Technology Indicators 2012/1.

Information from patent citations can also be used to understand the impact of Swedish technological output. Figure 2.33 presents national shares among the top 1% of highly cited patents in the EPO for Sweden and a number of other countries. Such a measure is highly sensitive to scale, with larger countries with larger research systems commanding greater shares. However, even systems of comparable size (in terms of magnitude of R&D resources) such as the pairs of France and the United Kingdom or Austria and Belgium, show considerable differences in citation rates. Sweden may be usefully compared to the Netherlands, a system with a comparable level of R&D resources. While the Netherlands had 3.28% of its national patents among the EPO's top 1%, Sweden had a smaller 2.61%. Moreover, the share of the Netherlands also grew faster over the period considered. The differences observed are small, however, and it is difficult to say whether the apparent shortcoming is indicative of a long-term trend linked to substantive performance issues or due to some other reason.

Figure 2.33. Highly cited patent applications to the EPO (top 1%), 1996-2000 and 2001-05

As a share of all EPO patent applications in the top 1% in their field.

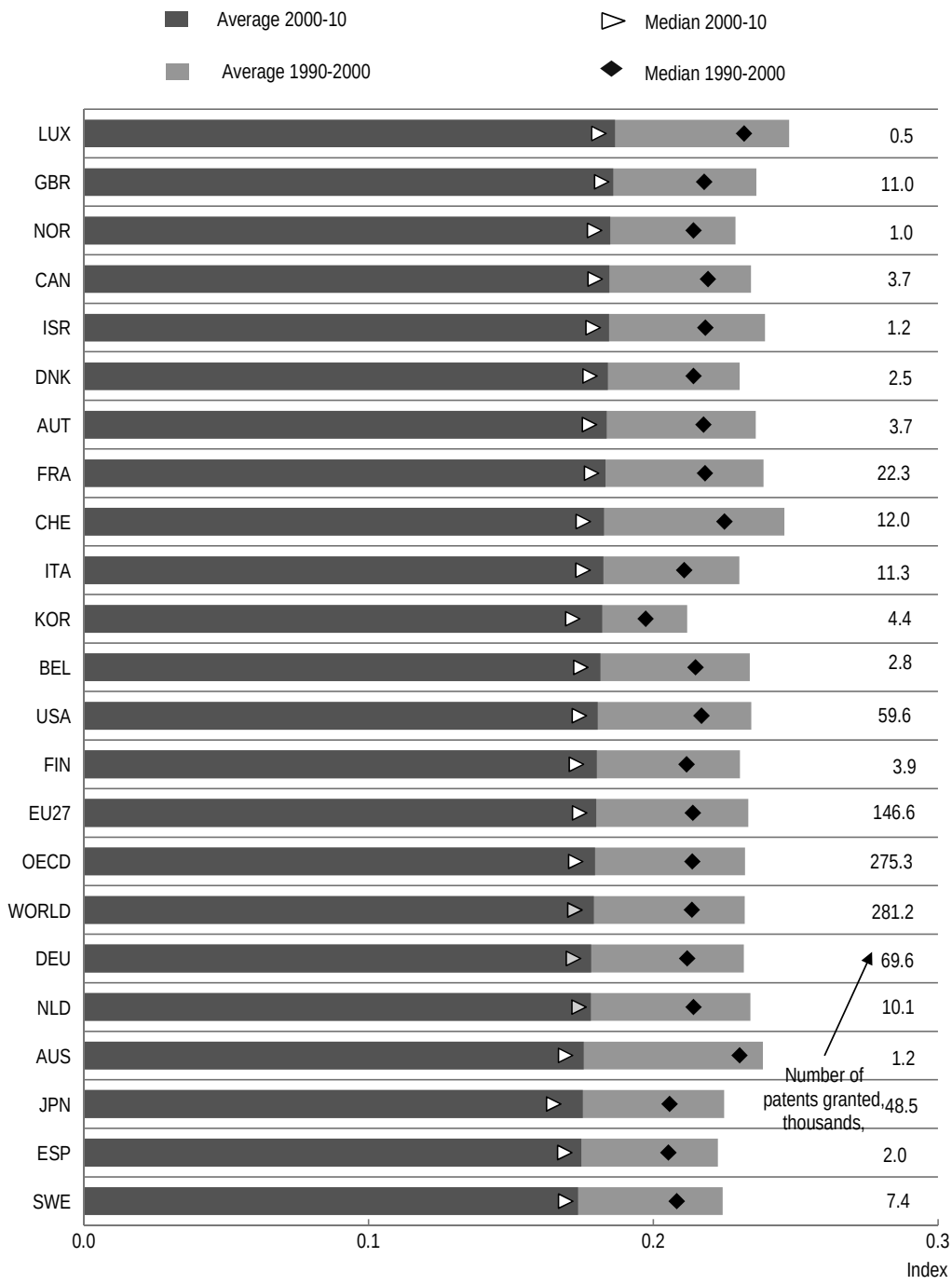


Source: OECD Science, Technology and Industry Scoreboard 2011.

Finally, a summary measure on quality of national patents can also indicate Sweden's international position and its evolution over time. Figure 2.34 presents the values of the OECD's (2011) Patent Quality Index (PQI) for Sweden and a number of other countries. PQI is a composite index based on a set of normalised indicators (backward and forward citations, family size, number of claims, grant lag and patent generality), ranging from 0 to 1 (maximum quality) (OECD, 2011). The patent quality indicators comprising the PQI are considered meaningful measures of research productivity and have been found to correlate well with the social and private value of the patented inventions (OECD, 2011). Sweden performs less well on that measure than most other countries with developed innovation systems.While its absolute performance has improved over time, its position with respect to other countries has not.

Figure 2.34. Patent quality index, 1990-2000 and 2000-10

Average and median



Note: The data refers to patents granted by the European Patent Office (EPO) up to 2010, by applicant's residence country and filing date. Only countries with more than 250 granted patents are included in the figure.

Source: OECD Science, Technology and Industry Scoreboard 2011.

Notes

1 Eurostat identifies knowledge intensive activities on the basis of "the level of tertiary education persons" across (NACE rev. 2) industrial sectors. Employment data are from the European Labour Force Survey (ELFS), the Japan Labour Force Survey (LFS) and the US Current Population Survey (CPS). More information can be found at *http://epp.eurostat.ec.europa.eu/cache/ITY_SDDS/EN/htec_esms.htm* (section 3.4, paragraph 10).

2 An even quality distribution would have 10% of total national publications among the most cited; if more than 10% of the total are among the most cited this is indicative of the prominence of high quality research; if less than 10% of the total are among the most cited this is a sign of the underrepresentation of high quality research in the system.

3 Classes 35 to 45 of the Nice classification (OECD, 2011, p. 62).

4 Business trademark applications designate Class 35; finance Class 36, telecommunications Class 38 and R&D Class 42 of the Nice classification (OECD, 2011, p. 62).

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Chapter 3

Innovation actors in Sweden

This chapter describes the main actors in the Swedish innovation system, their contribution to the system's dynamism and the main challenges they face. Businesses and universities are the main innovation actors. Sweden is home to highly innovative, export-oriented, internationalised firms operating at the technological frontier across a wide range of industries. Large firms dominate R&D expenditure in manufacturing industries, while smaller firms make a much larger contribution in the services sector. International comparisons suggest that the Swedish business sector has for the most part done well in the face of important global challenges. Sweden also possesses well-endowed and globally visible universities with a diverse range of strengths. However, universities currently face some long-term challenges. Compared to other world-leading countries there are signs of shortcomings in the impact of scientific research as evidenced in citations and commercial outcomes. In this context, the features of the funding system and of university governance are examined. Finally, human resources for science, technology and innovation are examined, highlighting the measureable decline in education quality.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

3.1. The business sector

3.1.1. Overall industry profile

Sweden has a high-performing business sector and is known for its innovative, export-oriented, internationalised firms. They operate in a wide range of industries: automobiles and components, telecommunications equipment, pulp and paper, chemicals and pharmaceuticals, packaging, and machinery end electrical goods. It also has a large services sector which contributes a comparatively large share of GDP. Each of the top ten firms – Volvo AB (engineering, trucks), Ericsson (telecommunications), SCA (pulp and paper), Electrolux (engineering, household appliances), Volvo Cars, Vattenfall and TeliaSonera (infrastructure), Skanska (construction), H&M (retail clothing) and ICA AB (retail) – had more than SEK 100 billion in turnover in 2010. A further group of large firms – Atlas Copco, Sandvik, Scania, SKF and companies in a range of service industries – has more than SEK 50 billion in annual turnover (GTAI, 2012). Large multinational enterprises (MNEs) such as ABB, TetraPak or AstraZeneca have important production and research facilities in Sweden. They have Swedish roots but, mainly owing to changes in ownership, their headquarters are located abroad.

The competitiveness of Sweden's industry is largely based on its strong R&D and broad innovation effort. The business sector as a whole spends approximately SEK 80 billion a year on R&D, of which around one-quarter is accounted for by the services sector.[1] R&D expenditures represent 2.9% of net sales in manufacturing and 0.6% in services (SCB, 2011b, pp. 14 *ff.*). As noted in Chapter 2, business expenditure on R&D (BERD) amounts to nearly 2.5% of GDP. BERD has traditionally been high, but has decreased from a peak of more than 3% around 2001. According to the Innovation Union Scoreboard (IUS), Sweden is the leading European country in the category "firm investments", which covers both R&D and non-R&D innovation expenditure (IUS, 2011). It has good to moderate, albeit recently declining, performance for in-house innovation by small and medium-sized enterprises (SMEs) and the introduction of new products and processes by SMEs. The same holds true for the collaboration intensity of innovative SMEs. Sweden leads among European countries in PCT patent applications per billion GDP.

In a sample of advanced countries, Sweden stands among the leaders. However, there are some indications of decline (Table 3.1). In 2006 Sweden had the second highest BERD in this sample (and the highest in Europe), but in 2010 it ranked fourth (and second in Europe). In addition, Austria, Denmark, Germany and Switzerland have narrowed the gap owing to higher growth of BERD.

Table 3.1. Business enterprise expenditure on R&D (BERD) as a percentage of GDP

	2000	2005	2006	2007	2008	2009	2010
Austria	..	1.72	1.72	1.77	1.85	1.85	1.88
Canada	1.15	1.14	1.14	1.09	0.98	0.99	0.91
China	0.54	0.91	0.99	1.01	1.08	1.25	..
Denmark	..	1.68	1.66	1.80	1.99	2.08	2.08
Finland	2.37	2.46	2.48	2.51	2.75	2.80	2.69
France	1.34	1.31	1.33	1.31	1.33	1.39	1.38
Germany	1.74	1.74	1.78	1.77	1.86	1.91	1.90
Israel	3.28	3.43	3.51	3.90	3.80	3.55	3.51
Italy	0.52	0.55	0.55	0.61	0.65	0.67	0.67
Japan	2.16	2.54	2.63	2.68	2.70	2.54	..
Korea	1.70	2.15	2.32	2.45	2.53	2.64	2.80
Netherlands	1.07	1.01	1.01	0.96	0.89	0.86	0.87
Norway	..	0.81	0.79	0.84	0.84	0.92	0.87
Sweden	..	2.59	2.75	2.47	2.74	2.54	2.35
Switzerland	1.87	..	..	..	2.20	..	..
United Kingdom	1.18	1.06	1.08	1.11	1.10	1.12	1.08
United States	2.02	1.80	1.86	1.93	2.04	2.04	..
Total OECD	**1.53**	**1.51**	**1.55**	**1.58**	**1.63**	**1.62**	**..**
EU27	1.11	1.09	1.11	1.12	1.15	1.17	1.16

Source: OECD Main Science and Technology Indicators, February 2012.

In nearly all industrialised countries, large enterprises account for most of R&D expenditure. This is true of Sweden, with its relatively large number of MNEs. The last few years reveal some interesting dynamics (Table 3.2). While aggregate expenditure remained more or less stable, R&D expenditures of foreign-owned enterprises, which account for a large fraction of Swedish BERD, have declined. (Their high share is largely the result of mergers or acquisitions of previously Swedish-owned firms, notably in research-intensive industries such as pharmaceuticals and the automotive industry.) At the other end of the spectrum, R&D expenditures of very small firms have declined significantly.

Table 3.2. R&D expenditure (BERD) by size class and ownership, 2009
SEK millions

	2005	2007	2009	Relative change 2005-09
10-49	7 014	5 594	5 080	0.72
50-249	9 848	10 090	9 495	0.96
250-	62 189	65 540	64 056	1.03
Manufacturing	57 224	56 903	59 557	1.05
Services	21 827	24 320	19 073	0.87
R&D in Sweden in Swedish-owned enterprises	41 556	47 548	50 092	1.21
R&D in Sweden in foreign-owned enterprises	37 495	33 675	28 538	0.76

Source: Growth Analysis (2011), p. 70.

The strong presence of large firms may give the impression that the R&D-performing SME population only makes a small contribution, but this is not the case. With BERD spending by SMEs at 0.48% of GDP, Sweden ranks sixth in Europe. Switzerland leads with 0.64%, followed by Denmark (0.56%) and Finland (0.52%). However, Sweden is nearly on a par with Austria and Belgium (both at 0.49%) and the EU average is only 0.25% (European Commission, 2011, p. 314). R&D expenditures differ across size classes and sectors. Large firms dominate in manufacturing industries, while smaller firms make a much larger contribution to overall expenditure in the services sector (Table 3.3).

Table 3.3. BERD by sectors and size classes, 2009
SEK millions

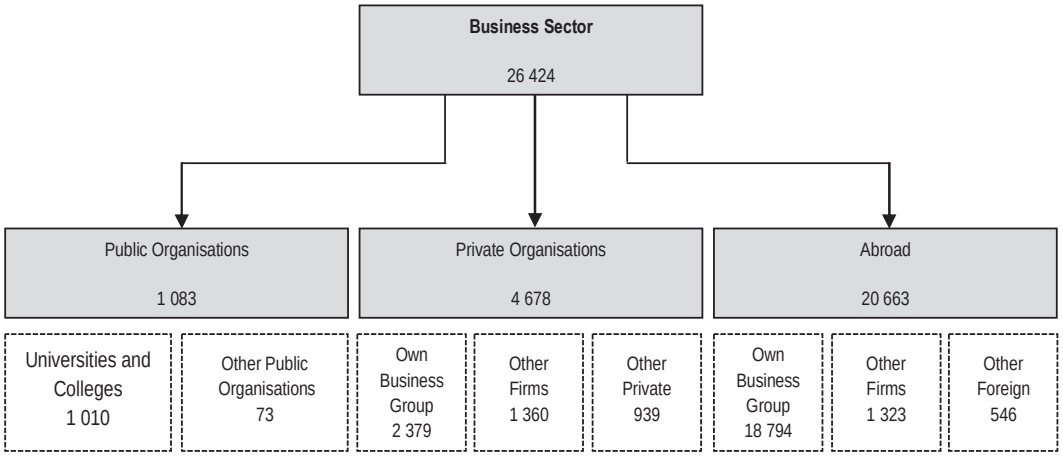
	10-49	50-249	250+	Total
All goods and services	**5 080**	**9 495**	**64 065**	**78 630**
Goods	3 154	6 027	56 948	66 130
Services	1 925	3 468	7 108	12 501
Metal, data- and electronic goods, optics, machinery	1 022	2 293	32 023	35 337
Cars and vehicles	495	420	11 855	12 770
Pharmaceutical	565	973	6 703	8 241
Chemistry	339	434	461	1 234
Other goods	358	582	2 827	3 767
Transport services	21	6	2 695	2 722
R&D providers	471	781	679	1 931
Other services	181	404	902	1 486

Source: SCB (2011a), p. 35.

As discussed in Chapter 1, a number of Swedish firms became important players on international markets during the 20th century. In recent years, the previously dominant model of domestic ownership, domestic production and domestic R&D is being replaced by firms that are often part of international conglomerates with global value chains and research and innovation networks. As a result of mergers and acquisitions some headquarters have moved abroad, and production and research facilities are increasingly distributed globally, although large Swedish firms have retained important R&D facilities in Sweden.

Figure 3.1 provides an overview of the flow of R&D funding emanating from Sweden's business sector in 2009. It does not cover "intramural" business expenditures on R&D (spent on R&D within the enterprise), the most important form of R&D funding, but traces flows to different types of "external" organisations. Overall, SEK 26.5 billion is spent outside the funding organisation. SEK 20.7 billion (78%) goes to foreign units, of which SEK 18.8 billion to entities belonging to the same business group. Therefore, the most important "external" recipients by far are foreign affiliates of Swedish MNEs. Private organisations receive around SEK 4.7 billion, of which roughly half stays within the business group. Only SEK 1 billion (4.1%) is directed towards public organisations (almost all of which funds research by universities and colleges).

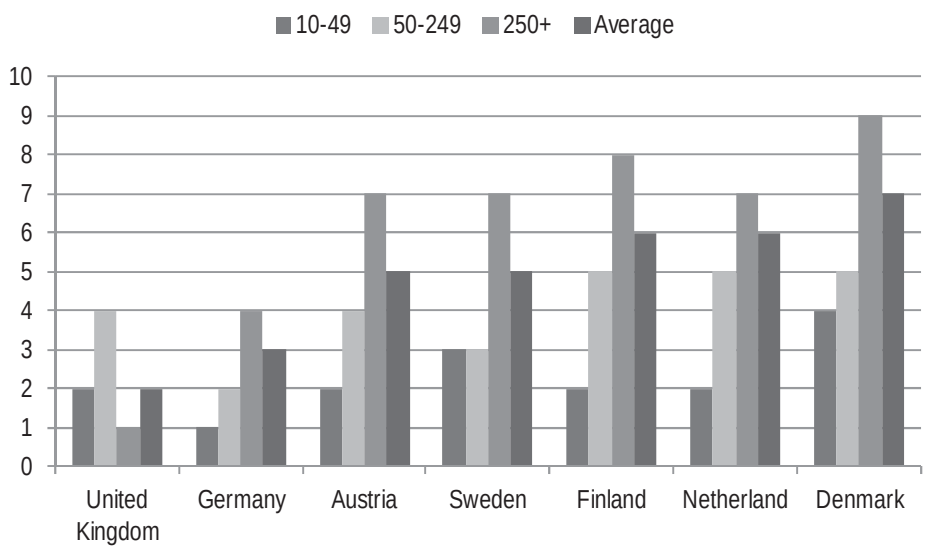
Figure 3.1. External R&D funding by the business sector
SEK billions



Source: SCB (2011a), p. 28 (own translation). Updated 24 November 2011.

Because of past successful innovation, Sweden has a large surplus in the technology balance of payments, with receipts (2010) on a par with those of Switzerland (OECD Main Science and Technology Indicators 2012/1). A number of other indicators also place Sweden among the top European countries, as would be expected for an innovation leader. However, firms in a number of comparator countries – Switzerland, Denmark, the Netherlands and Finland – seem more successful in bringing innovations to the market and generating revenues, while Austria is on a par with Sweden (Figure 3.2).

Figure 3.2. The share of revenue from products and services that are new to the market in total revenue, 2008



Source: Growth Analysis (2011), p. 75, based on Eurostat.

Overall, innovation expenditures of Swedish firms are among the highest in the world and have a leading place among comparator countries across Europe. This reflects the overall good position, the strong role and the high R&D expenditures of large firms.

3.1.2. Major industrial sectors

Sweden has a diversified industrial landscape, including when compared to other Nordic countries. Often seen as specialised in high technology, it also has a strong base in a number of medium-technology sectors which rank among the top performers worldwide in their respective fields. The most important of these sectors are described below.

Cars and car components are an important part of Swedish industry. The region of Västra Götaland specialises in this sector. Volvo AB (trucks, components, aero, engineering) is the largest Swedish firm, with Volvo cars, Scania, the now ailing carmaker SAAB, and second-tier firms such as Autoliv or Haldex as other major actors. The car industry has the second highest R&D expenditures in Swedish industry: approximately SEK 16 billion in 2009 and nearly 8% of turnover. Nearly 10 000 full-time equivalent (FTE) R&D personnel constitute 12.5% of the total (SCB, 2011b). The Volvo group alone claims to have 13 000 R&D staff worldwide, of whom 60% are in Sweden.

Aerospace is another research-intensive, but smaller, industrial sector, with actors such as SAAB or Volvo Aero. For a small country aerospace has a strong industrial presence, built on a strong past and some current military effort, notably by the SAAB group. The legacy also includes strong public-private partnerships. The industry has diversified into propulsion, components for civil aviation and space equipment. In 2007 around USD 290 million were spent for R&D.

Machinery and electro/electronics, including *optical industries* and *telecommunication equipment suppliers* constitute Sweden's main research-intensive industry sector. It has a range of actors and a variety of competencies. Global players such as Ericsson, Alfa Laval, Sandvik, SKF or the Swedish ABB form traditionally strong industrial cores. The machinery industry had about SEK 200 billion in turnover in 2010, and Ericsson alone accounted for another SEK 200 billion. It is Sweden's biggest export company, with 8.8% of total exports in 2010, down from a peak of 19.7% in 2001 (Erixon, 2011, p. 72). Ericsson can also be viewed as a key transmitter of foreign knowledge to the Swedish innovation system. Over more than two decades, it successfully transformed itself from a hardware producer to a broad ICT production *and* service company, with the help of government technology policy (see Arnold *et al.*, 2008; Erixon, 2011, pp. 71 *ff.*). All sub-sectors taken together spent around SEK 27 billion on R&D in 2009, and its 17 000 R&D personnel accounted for 9.4% of the sector's total workforce. Much of the S&T output, including patents, can be attributed to this large sector. Science, technology and innovation policy provides support through science-industry co-operation initiatives. The VINNOVA Vinn programme operates five competence centres in ICT and another five in materials (VINNOVA, 2009a).

The *pulp and paper industry* had a turnover of approximately SEK 200 billion in 2009. The industry employs around 1 800 R&D personnel (5.7% of all employees). R&D expenditures amounted to more than SEK 3 billion in 2009 (SCB, 2011b). In an international comparison, the Swedish (like the Finnish) pulp and paper industry is characterised by a high degree of concentration and modern mills, with important actors such as SCA and the Swedish-Finnish Stora Enso. The industry invested early in process and environmental technologies, owing in part to government environmental regulations in Sweden and abroad, notably in Germany, its main export market, and also to societal pressure and considerations of industrial risk. R&D investments have been higher than in other main producer countries over a longer period of time (Foster *et al*., 2006, pp. 122–40).

Chemistry, including *pharmaceuticals*, is also a large industry sector. It has an annual turnover of SEK 180 billion and around 35 000 employees (2008) (GTAI, 2012). In the pharmaceutical industry alone, R&D personnel account for nearly 35% of all personnel (4 700). The chemicals industry has 1 700 R&D personnel (9.4%) (SCB, 2011b). In 2009, the pharmaceutical industry spent more than SEK 6 billion on R&D (9% of sector turnover but a considerable decline from 2007; SCB, 2011b). Apart from some basic and specialised branches, such as chemicals for the pulp and paper industries, the pharmaceutical industry is still the most important segment in this sector. It can rely on a strong scientific base in Sweden. The industry was affected by the withdrawal of Pharmacia's (now Pfizer's) capacities from Sweden, and lately also from reorganisations and relocations at AstraZeneca, the most important of the firms. Pharmacia and Astra have become parts of larger MNEs since the 1990s. However, the history of Pharmacia shows that much of the sector's know-how and research capacity has survived and even grown through buy-outs and other processes. The recently announced closure of AstraZeneca's large Södertälje laboratories has drawn much attention. Many firms are located in the Stockholm and Skane regions, and science and technology policies strongly support the pharmaceutical industry through various instruments.

Medical technologies benefit from the highly developed Swedish health system and from a number of new establishments such as the Nya Karolinska university hospital in Stockholm. The industry has an annual turnover of about SEK 23 billion and is dominated by a few large firms such as Getinge, Gambro (formerly part of ABB) and Mölnycke, which are clustered in the Stockholm, Gothenburg and Malmö areas. On the broader life science industry in Sweden, see Box 3.1.

Box 3.1. The life science industry in Sweden: Strengths and challenges

The life science industry in Sweden is composed of three segments, biotechnology, pharmaceuticals and medical technology. All have both small and large actors. A recent publication (Sandström *et al*., 2011, p. 5) provides the following overview: Former big players have reduced their presence in Sweden over the last decade, notably U.S.-based Pfizer which, after the takeover of Pharmacia, had been very strong in Sweden. AstraZeneca, with headquarters in London, is also closing facilities in Sweden. A large part of the smaller firms belongs to the biotech segment, including a number of university spin-offs. Traditionally this sector, notably the pharmaceutical producers, makes a positive contribution to Sweden's trade balance. Taken together the sector had over 700 companies and around 32 000 employees in 2009. This is a considerable industrial strength, however Denmark, a much smaller country, has an even larger industrial sector in the Life Sciences. [1]

In more detail the sector is structured as follows, excluding sales and marketing companies. In 2009, AstraZeneca still accounted for a quarter of all employees, followed by only three firms with more than 1 000 employees each. The number of micro-sized companies (1-10 employees) grew more than threefold from 130 in 1997 to 430 in 2009. The number of small (11-50) and medium-sized firms (51-250) also grew during this period. Overall employment increased by 38% in the period between 1997 and 2009 but decreased by some 7% between 2006 and 2009. The main cutbacks were in the largest firms, with an overall reduction of more than 4 400 employees between 2005 and 2009. A new difficult period started with the recent closures of large AstraZeneca research facilities in Lund, and the 2012 announcement of the dismantling of the Södertälje labs will lead to a loss of another 1 200 jobs, mainly in R&D. This is seen as a serious setback to Sweden as a research location, as "a vital share of overall industrial research is now disappearing"[2] and weakening its competitive advantage in international trade. The Swedish government works together with academia and industry to retain competencies and plans to establish co-operative research structures. Restructuring in the pharmaceutical industry is not necessarily bad: the Pharmacia story shows that Pfizer is now small in Sweden but a similar number of about 5 000 employees work in a dozen spin-off or sold-off companies (Sandström *et al*., 2011, p. 32).

…/…

Box 3.1. The life science industry in Sweden: strengths and challenges *(continued)*

In 2009, more than 10 000 employees worked in drug discovery and development, still the largest part of the Swedish life science industries, although it has become much smaller since 2006. AstraZeneca and the remaining Pfizer companies concentrate on drug discovery and development and less on drug production. A number of smaller segments (each with 1 000-2 000 employees) cover drug production, medical biotechnology, biotechnology tools and various sub-segments of medical technologies (Sandström *et al*., 2011, p. 14), followed by a large number of small, specialised industrial segments. Regional concentration is highest in the Stockholm/Uppsala region with more than 50% of all employees, followed by the Skane region with nearly 20%. The three sub-sectors are of nearly equal size (see Sandström et al., 2011, pp. 17 *ff*.) and all have a considerable to dominant share of foreign ownership:

- Pharmaceutical companies have nearly 15 000 employees and are dominated by drug discovery and development (and still by AstraZeneca). There are limited pharmaceutical production facilities, which are in some cases former Pharmacia or Astra facilities taken over by other producers.
- Biotechnology companies have over 16 000 employees in a larger number of firms. Although drug development also dominates, the portfolio of activities is broader. Some companies are quite large and include spin-offs from former Pharmacia.
- Medical technology companies employ some 15 000 people in a broad range of activities performed by companies of all size classes. This industry has a strong "Mittelstand".

Overall the Swedish life sciences industry has considerable strengths, including many university spin-offs, a balanced industrial portfolio, high value added and a strong research base. Collaborative funding and good framework conditions for clinical trials are further strengths, as are research-friendly regulatory frameworks. On the downside, core industrial actors are reducing their research capacities and other strengths seem to be eroding as the following example of clinical research shows. This development is of special importance as flexible and generous framework conditions for clinical research are seen as important for the life sciences industry in Sweden.

Sweden is renowned for its clinical research in academic institutions such as the Karolinska Institutet but also in hospitals close to academic research with a long tradition in clinical studies, supported by career tracks, research-friendly regulation and available funds. Sweden, along with Switzerland, is a world leader in medical publications, with nearly 700 publications a year million inhabitants, followed by Denmark, Finland, Israel and the Netherlands (Academy of Finland and Vetenskapsrådet, 2009, p. 21; Karlsson and Persson, 2012). This represents 1.5% of world biomedical research publications and a good but stagnant, and in some respects deteriorating, position as a research location (Karlsson and Persson, 2012). For academic actors, outputs and impacts see the section on universities.

Over time clinical research careers have become less attractive for young MDs, while other career paths have become more so. Numbers of publications have not increased over the last years and technology transfer is not fully developed. A recent evaluation (Academy of Finland and Vetenskapsrådet, 2009, p. 9) covering Sweden and Finland proposed reforms in education and career paths to allow for double track careers. Research-active MDs are too old when they finally become independent (or even enter a real position); there is not enough time for research when compared to standard medical care; and this career path does not offer high-paying jobs, so many talented young people go elsewhere. Numbers of combined MD-PhDs have declined. More research money should allow for longer studies and be more strongly based on merit. Other recommendations include a boost in internationalisation and attention to regulatory matters; overall the evaluation sees an "alarming" signal. The bibliometric analysis reveals that Sweden's previous pre-eminence and research output are declining. More importantly, the evaluation panel found a widespread perception that the previously favourable circumstances for clinical research are rapidly eroding (Academy of Finland and Vetenskapsrådet, 2009, p. 9).

1. Sandström *et al*. (2011), p. 41, count more than 37 000 employees, of whom more than 25% in drug discovery and development.

2. VINNOVA press release, 16 February 2012: *www.vinnova.se/en/misc/menues-functions/News/2012/120216-VINNOVA-Director-General-proposes-Life-Science-partnership/*

Source: Sandström *et al*. (2011); Academy of Finland and Vetenskapsrådet (2009).

The *services industries* spend around SEK 20 billion on R&D, a quarter in ICT services, but more than 40% in special "R&D institutions". Although services account for only a quarter of overall R&D expenditure, over 70% of R&D performed by very small firms (10-49 employees) is in the services sector and over 60% in firms with 50-249 employees (SCB, 2011a, p. 17). Sweden's highly developed logistics sector ranked third worldwide after Germany and Singapore in the World Bank Logistics Performance Index 2010 but dropped to thirteenth place in 2012) (World Bank, 2010). Sweden's strong sea and land transport infrastructure supports the innovative, export-oriented producing sectors. Moreover, the increasingly blurred borderline between manufacturing and services is exemplified in the trend towards "servitisation" of manufacturing, which is already quite advanced in Swedish industry (Box 1.2).

So far Swedish companies have succeeded in specialising at the high end of global value chains (GVCs). They have also been able to deal with the shifting and increasingly blurred borderline between manufacturing and services. The share of manufacturing in employment and – to a lesser extent – in value added, has declined and the relative weight of services is increasing (*e.g.* Ericsson). Yet, in contrast to other OECD economies that have undergone marked deindustrialisation, manufacturing is still a very important part of the Swedish economy. At the same time market services – in many cases related to manufacturing activity – make up an increasing and dynamic part of the economy. More broadly, innovation in services, which is often not based on R&D, has become an increasingly important factor in driving overall productivity growth. Maintaining an edge in technology, and more broadly in innovation, is critical for companies in high-income countries if they are to achieve productivity growth and maintain their international competitiveness in the longer term.

Box 3.2. The servitisation of Swedish manufacturing

Swedish manufacturing is becoming "servitised", as manufacturing now both buys more services and produces more services in-house and also sells and exports more services. Manufacturing firms' purchases of services (Kommerskollegium, 2010) more than doubled between 1975 and 2005 as a share of production value. However, costs are increasingly dominated by services produced in-house, especially by qualified services production. [An increasing number of employees in manufacturing are in service-related occupations. In 2006, almost half of manufacturing employees worked in service-related occupations if employees in subsidiaries are included.

Industrial companies also develop more and increasingly complex industrial service offerings. Swedish manufacturing firms sell and export more services than they did a decade ago. The share of services sales in total turnover has risen by 25% if subsidiaries are included. This indicates that the industry's sales have broadened (diversified). Furthermore, sales of services – as a share of total turnover – are almost 60% higher than indicated in official statistics when all manufacturing subsidiaries are included.

Swedish-based manufacturing firms state that an important reason for their move towards servitisation is to avoid exposure to price competition from low-cost countries. Another reason is the fact that new services can open new revenue streams that will help to mitigate effects of shifting demand in production and products owing to business cycle fluctuations (VINNOVA, 2009b).

Source: Kommerskollegium (2010); VINNOVA, (2009b).

Sweden boasts many clusters, but only a few are large. In an international comparison, only the information technologies cluster in Stockholm and the automotive cluster in Västra Götaland can be seen as fully "three star clusters" (Ketels, 2009, pp. 36 *ff.*).[2] Sweden's relative specialisation in thematic clusters is lower than in comparable European countries. Most are in more traditional fields of economic activity, and only a few new (and high-technology) clusters are developing (Ketels, 2009, p. 33).

Overall and across sectors, the Swedish economy appears to benefit from a high degree of innovativeness, based on considerable investments in R&D. Nevertheless there are recurrent concerns about the efficiency of R&D investment, the impact of globalisation, and issues relative to SMEs and entrepreneurship. There are three main issues. The first is the relation between input-output, commonly known as the "Swedish R&D paradox" (Box 3.3). Second, there are concerns about Sweden as a future research location, as businesses that were once firmly rooted in Sweden are now increasingly globalised MNEs. The third concerns the number of innovative SMEs, their growth (potential), levels of entrepreneurship and the potential for new growth sectors to emerge.

Box 3.3. The "Swedish (R&D) paradox"

Discussion of the Swedish R&D "paradox" can be traced back to the early 1990s and placed against the backdrop of the search for an explanation of Sweden's unsatisfactory economic performance at the time. While the paradox is expressed in various ways, it postulates that Sweden's high level of R&D input (*i.e.* R&D expenditures, researchers and other innovation expenditures) does not translate into a proportionately high level of output (*i.e.* patents, licensing income or economic growth). Over the past two decades, the literature on the Swedish national innovation system has debated the precise form, magnitude and possible explanations for the purported paradox (Edquist and McKelvey, 1998; Bitard *et al*., 2008; Ejermo *et al*., 2011; Ejermo and Kander, 2011).

Evidence of the existence or persistence of the paradox is mixed. To some extent, the long-term evidence challenges certain aspects of the "paradox": In an analysis based on long technological waves and patenting trends, Ejermo and Kander (2011) observe that many mature industrialised countries are in a comparable situation as regards productivity of R&D inputs in high-technology sectors. In any case, the trend in Sweden from 1985 to 2002 appears to be positive. Nevertheless, there are reasons for concern. First, the performance of services over time is uneven. Second, research productivity has grown especially in low- and medium-technology manufacturing, such as transport and chemicals. Ejermo *et a*l. (2011) find that the paradox holds for fast-growing sectors, an apparent indication of diminishing returns rather than a substantive system failure.

Even in areas in which the "paradox" may persist, the policy implications (if any) are not clear. It is difficult to evaluate the extent to which it is due to substantive efficiency problems (*e.g.* related to framework conditions or to the governance of innovations) or merely a reflection of industrial/sectoral specialisation patterns and the associated R&D productivity (conditioned among others by the novelty of the knowledge domain), or even the international outlook of Swedish business and the resulting propensity to register output outside of Sweden.

3.1.3. Challenges and opportunities of globalisation for large firms

Sweden embraced internationalisation early, and over the course of time has derived significant benefits from this move. Today Sweden is a very open economy. This means that it is better prepared than many other countries to operate in changing international environments and seize emerging opportunities (Rae and Sollie, 2007). However, it also means that the profound ongoing changes in the global economy and the rise of emerging economies, most prominently in Asia, will have a major impact on Swedish businesses and the Swedish economy at large. Competitive pressures are increasing in many areas as emerging economies strengthen and upgrade their capabilities. China, in particular, is investing heavily in its skills and knowledge base in R&D and ICT. Companies from emerging economies have already become, or are on the way to becoming, competitors of global leaders, e.g. in communications technology. In areas such as telecommunications equipment, Chinese firms now compete in global markets. Competition for hosting research centres, and not just production sites, has increased. Accordingly, the risk of production and research activities moving offshore has increased. It may become harder to retain and to attract economic activities to Sweden.

Globalisation has profoundly transformed large Swedish enterprises. Foreign ownership has increased, particularly since the 1990s. Swedish-based MNEs – irrespective of their ownership structure and including firms like AstraZeneca – now have many more employees abroad than in Sweden. In 1987 these firms had 750 000 employees in Sweden and another 500 000 worldwide. In 1998 they had 650 000 employees both in Sweden and abroad, but by 2009 they had slightly over 400 000 employees in Sweden and more than 1.1 million worldwide (Andersson *et al*., 2012, pp. 12 *ff*.)

In a series of mergers and acquisitions the two passenger car firms and the two big pharmaceutical companies became parts of larger multinational enterprises (on the pharmaceutical industry see Box 3.1.). In the car industry persistent attempts by local management and public authorities to rescue companies with brands in high-quality niches failed to offset fully certain disadvantages, notably their small scale, in a competitive global market. In one case this led to a new takeover, in the second operations temporarily ceased. In the area of energy technology and mechanical engineering, one of the largest Swedish actors became a bigger actor through a European merger of equals. Sweden's largest telecommunications equipment provider successfully embraced digitisation but underwent a severe restructuring in the first half of the 2000s, having transformed itself from a global hardware provider into a global service company. Finally large infrastructure providers became international players.

Irrespective of ownership, however, large enterprises – both domestic and foreign-owned – are guided by their global corporate strategies. Activities and related resources are reallocated within global corporate structures. New, more open, models of innovation and the emergence of new global centres of R&D are driving an ongoing process of reallocation, including of corporate R&D resources. R&D staff is still strong in Sweden in the largest companies: The top ten industrial actors still account for more than 30 000 R&D staff (ranging from over 9 000 to 1 000 employees). However there is a downward trend, with some firms considerably downsizing (Andersson et al., 2012, pp. 38 f.).

As indicated, much inward foreign direct investment (FDI) in R&D in Sweden has taken place through mergers and acquisitions. By contrast, very prominent examples of R&D-related (re)locations of foreign research or R&D-intensive production units to Sweden seem to be scarce. Large-scale inward (re)locations have been recorded by other high-income countries such as Switzerland and the United States owing to the quality of their research infrastructure or more liberal regulatory frameworks. Prominent examples are the establishment by European, including Swiss, "Big Pharma" of research facilities in the Boston area in the United States or, in the other direction, the establishment of IBM's research laboratory in Rüschlikon near Zurich, a city that has also attracted Google and Disney Research.

3.1.4. How innovative are Swedish SMEs?

The size distribution of firms is a function of a country's industrial specialisation, integration into international markets and macroeconomic conditions (*e.g.* availability of finance for investment), microeconomic environment (shaped by long-term industrial and competition policy) and institutional framework conditions (especially enforcement of contracts and the impact on transaction costs). Whereas large firms command scale advantages that are central to economic efficiency (and ultimately to global competitiveness), smaller firms can be the source of much innovative dynamism. Smaller firms often generate novelty in sectoral and technological niches that may be otherwise neglected. SMEs may act as a vehicle for the commercialisation of radical, or at least unconven-

tional, innovations, such as new business processes. A large and dynamic pool of SMEs may therefore help to shift technological change more rapidly towards emerging sectors. Less directly, a vibrant pool of SMEs can indicate the absence of barriers to entry and more generally of competitive pressure, a key determinant of innovation.

Sweden has the same number of SMEs relative to the total population of firms as the EU27 average (Table 3.4). Within this overall picture there are of course differences. The share of large firms in employment is higher (36.3% compared to the EU average of 32.6%) and their share of value added is also larger. Within the SME sector Sweden has more micro-enterprises than the EU average but fewer small firms (4.8% *vs*. 6.9%) and medium-sized ones (0.8% *vs*. 1.1%). In total Sweden's 550 000 SMEs employ more than 1.7 million people and contributed more than 55% of the economy's value added.[3] While there are differences overall, they are not very large (Table 3.5).

Table 3.4. SMEs in Sweden: Enterprises, employment, value added

	Enterprises			Employment			Value added		
	Sweden		EU27	Sweden		EU27	Sweden		EU27
	Number	Share	Share	Number	Share	Share	EUR billion	Share	Share
Micro	523 126	94.2%	91.8%	685 631	24.7%	29.7%	37	20.2%	21.0%
Small	26 486	4.8%	6.9%	578 795	20.%	20.7%	32	17.2%	18.9%
Medium-sized	4 661	0.8%	1.1%	501 667	18.1%	17.0%	33	18.0%	18.0%
SMEs	554 273	99.8%	99.8%	1 766 093	63.7%	67.4%	101	55.8%	57.9%
Large	968	0.2%	0.2%	1 005 178	36.3%	32.6%	80	44.2%	42.1%
Total	555 241	100.0%	100.0%	2 771 271	100.0%	100.0%	181	100.0%	100.0%

Source: Hytti and Pulkkanen (2010), p. 14, Table 6; European Commission (2009).

The lack of "visibility" of Swedish SMEs, together with more general concerns about a lack of entrepreneurial spirit, is a subject of debate in Swedish innovation policy discussions. As mentioned, this is linked to the dominant role of large firms as regards investments in R&D, absorption of talent and agenda setting (the latter together with the leading universities). These views are seen by some as related problems: a lack of successful small firms may hinder the development of new industrial dynamics, but large firms, which may be weakened by the some effects of globalisation, consume most of the resource (attention, talent, public support). While regional innovation policy actors show an intense interest in existing SMEs, the important "middle layer" of firms that are larger than SMEs but considerably smaller than the globalised industrial giants seems to receive much less attention.

An important question (related to the Swedish "paradox" referred to above) is whether Swedish SMEs are less active in R&D (and in innovation more broadly) than their peers in other advanced countries. Table 3.5 does not show that R&D expenditures by Swedish SMEs are weak: Swedish firms of all size classes are at or near the top in terms of BERD as a percentage of GDP.

Table 3.5. Business expenditures on R&D by firm size classes, 2007
Percentages

	10-49 in relation to GDP	50-249 in relation to GDP	250+ in relation to GDP	250+ as % of all R&D	Share of five largest R&D performers
Germany	0.05	0.13	1.58	89.8	57
United Kingdom	0.04	0.14	0.94	83.9	26
Finland	0.18	0.26	2.01	82.0	88
Sweden	0.17	0.31	2.17	81.9	74
Switzerland (2004)	0.15	0.27	1.70	80.2	80
Netherlands	0.07	0.15	0.75	77.3	76
Austria	0.13	0.32	1.21	72.9	58
Denmark	0.15	0.3	1.21	72.9	--

Source: Growth Analysis (2011, p. 68), based on Entreprenörskapsforum (2010), p. 111.

In 2007, firms with more than 250 employees accounted for over 80% of Swedish BERD (Table 3.5). This is not exceptional. In Finland, Switzerland and the Netherlands the share of BERD accounted for by firms with more than 250 employees is also around 80%, and it is even higher in the United Kingdom and especially in Germany (nearly 90%). In a group of comparator countries, only Austria and Denmark have a lower share (73%). One could argue that a handful of very large firms is a specific feature of Sweden (*e.g.* IVA, 2011). This is in many respects valid, of course. Yet, in Finland, Switzerland and the Netherlands the five largest R&D-performing firms account for a higher share of BERD than in Sweden (Growth Analysis, 2011, p. 68). On this account, and among comparator countries, Sweden has a high concentration of BERD but is not an outlier. This observation is confirmed for more finely grained size bands: firms with 10-49 employees account for 6% of BERD, those with 50-99 employees for 5%, those with 100-249 employees for 7% (together 19%), those with 250-499 employees for 10%, those with 500-999 employees for 6% and those with more than 1 000 employees for 66% (SCB, 2011a, p. 18). This overall distribution is broadly comparable to Austria's where firms with fewer than 50 employees account for 11% of BERD, those with 50-249 employees for 18% and those with more 250 employees for 71% (Federal Ministry of Science and Research, 2012, p. 39).

SMEs accounted for around SEK 15 billion in R&D expenditure in 2009, a figure again comparable to that of Austria.[4] Firms with 50-249 employees had annual R&D budgets of about SEK 10 billion over the last years, growing during 2005-07 and then falling in 2009 to the level of 2005. R&D expenditures among firms with fewer than 50 employees shrank from SEK 7 billion in 2005 to SEK 5 billion in 2009, with a sharp decrease even before the financial crisis of 2008 (Growth Analysis, 2011, p. 70). The reason for this decrease should be further explored. At the same time, SMEs accounted for 13% of FP7 co-operation funding received by Sweden in 2007-12 compared to an EU average of 16%.[5]

Table 3.6 notes the shares of innovative firms per size class and main sector. Sweden possesses large shares of innovation actors among SMEs in both the manufacturing and services sectors.

Table 3.6. Share of innovative firms (%) per branch and size class, 2004-06

No. of employees	All	Industry (10-37)	Manufacturing (15-37)	Services (51-74)	Financial services (65-67)
< 10	44	51	52	39	51
10-49	40	46	46	37	44
50-249	55	64	64	47	55
> 250	72	81	81	61	87

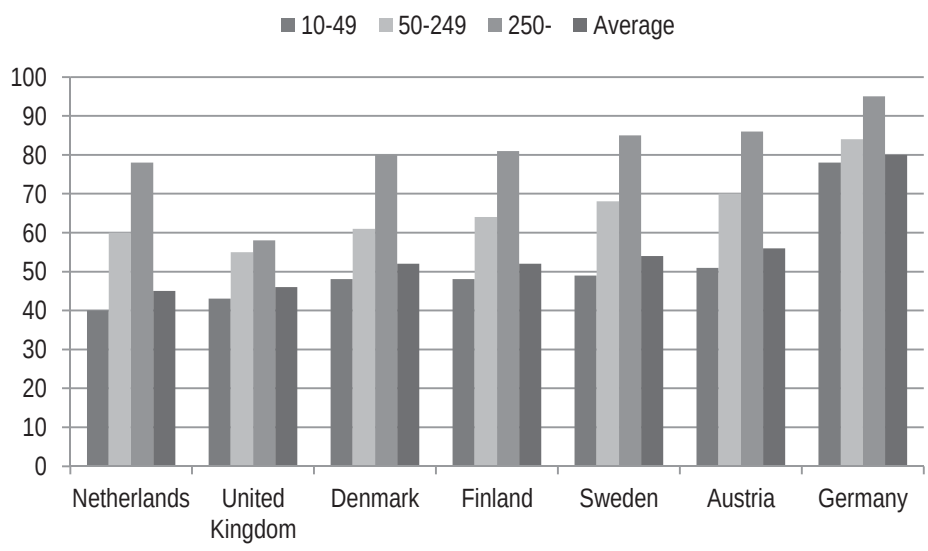
Source: Hytti and Pulkkanen (2010), p. 16, Table 8, data from SBA.

A 2007 national survey cited in Hytti and Pulkkanen (2010, p. 16) reports that 22% of a sample of SMEs were active in R&D, 31% were engaged in innovation activities and 37% performed either R&D or innovation. The majority of firms use their own resources for financing innovative activities and report lack of time and resources as the strongest obstacles. Though many firms claim a strong interest in doing so, few SMEs co-operated with universities or research institutes. Swedish SMEs rarely file for patents.

Further evidence of the innovativeness of Swedish SMEs is provided by an EU-wide comparison across firm size bands (Figure 3.3). Compared to a number of other countries, both the 50-249 and 10-49 segments have considerably high shares of firms with innovation activities. Sweden is ahead of Finland, Denmark, the United Kingdom and the Netherlands and nearly on a par with Austria (Growth Analysis, 2011, pp. 74 *ff.*; see also Figures 3.3-3.5). Smaller firms in Sweden do not appear to be at a disadvantage compared to other countries of similar size and/or R&D intensity.

Figure 3.3. Share of enterprises with innovation activity, 2008

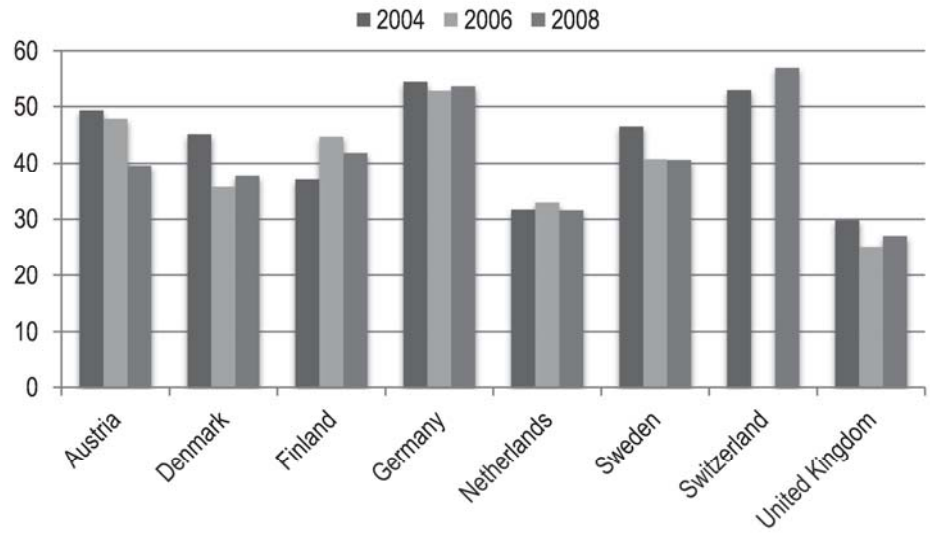
Average and distribution by employment size



Source: Growth Analysis (2011), p. 74, based on Eurostat Community Innovation Survey (CIS) 2006-2008.

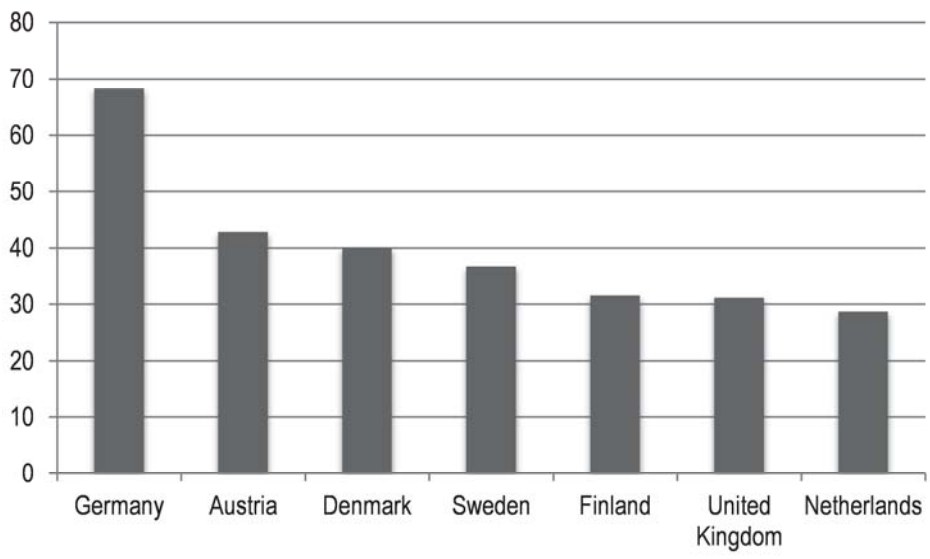
EU Innovation Union Scoreboard data show that Swedish SMEs seem quite competitive as introducers of new products and processes. They do not belong to the top tier in a comparison of leading European comparator countries, but they have a strong middle position (Figure 3.4). A similar pattern can be observed for market or organisational innovations (Figure 3.5).

Figure 3.4. SMEs introducing product or process innovations as a percentage of all SMEs



Source: Growth Analysis (2011), p. 39, based on ProInno Metrics IUS database 2010.

Figure 3.5. SMEs introducing market or organisational innovations as a percentage of all SMEs



Source: Growth Analysis (2011), p. 39, based on ProInno Metrics IUS database 2010.

With respect to other innovation indicators by SMEs, international comparisons are somewhat less favourable to Sweden. In the four SME-related indicators provided in the Innovation Union Scoreboard (IUS), Sweden is nowhere in the lead, ranking fourth in three categories. The category "sales of new to market/new to firm innovations" includes all firm sizes and Sweden ranks very low. However, it ranks first in EU-wide comparison for the share of innovative firms that bring new or significantly improved products to market, as opposed to innovative firms that are "only" design or marketing innovators (European Commission, 2011, p. 321). Sweden's middling position on a number of indicators of innovation in SMEs contrasts with its leading overall position in the EU, and second only to Switzerland in Europe.

While the imperfect nature of international survey data calls for caution in drawing conclusions,[6] the data in Table 3.7 highlight differences between Sweden and similar countries that are pronounced enough to raise the possibility of systemic issues. This applies less to changes over time (annual average growth, in brackets) as these are influenced by macroeconomic developments and possible sampling differences in the various iterations of the Community Innovation Survey (CIS) and its successor, the IUS. The relative position of Sweden is compared to the EU average in a sample of six comparable countries in terms of size and/or innovation performance. Sweden ranks fourth for in-house innovation, second for the share of innovative SMEs collaborating with others, third for SMEs introducing product and process innovations, and fourth (in a five country comparison) for marketing or organisational innovations. The apparent weakness of Swedish firms with respect to marketing and organisational innovations should be taken seriously as these forms of innovation are important for the services sector.

Table 3.7. Innovation in SMEs: Relative position and change, 2006-10
EU average = 100 (annual average growth in brackets)

	Sweden	Finland	Denmark	Austria	Germany	Switzerland
SME innovating in-house	122 (- 3%)	127 (+ 3.3%)	135 (0%)	113 (- 5.1%)	152 (- 0.1%)	93 (- 4.8%)
Innovative SME collaborating	148 (- 4.7%)	137 (- 3%)	199 (+ 1.7%)	132 (- 5%)	80 (+ 1%)	84 (- 6.1%)
SME introducing product/ process innovations	119 (- 3.3%)	122 (+ 3.1%)	110 (- 4.4%)	116 (- 5.4%)	157 (- 0.3%)	159 (0.7%)
SME introducing marketing/ org. innovations	94 (0%)	81 (0%)	102 (- 10.6%)	109 (- 5.3%)	160 (+ 1.3%)	N/A

Source: Own compilation from European Commission (2012), pp. 53, 54, 68, 74, 75 and 81. For calculating average annual growth, see pp. 85 f.

In conclusion, the distribution of R&D expenditures across firms of various sizes is broadly comparable to other technologically advanced countries. Sweden is not exceptional in terms of the concentration of business R&D among top performers. The propensity of Swedish SMEs in particular to innovate, though not in the lead internationally, appears to be broadly in keeping with SMEs in other technologically advanced countries. A decline in small business (fewer than 50 employees) R&D expenditures and perceptible shortcomings with respect to marketing and organisation innovations are areas that may require targeted policy interventions. Prior to this, however, Swedish innovation policy might put some effort into deeper analysis of SMEs and "Mittelstand" (250+) enterprises and their innovation behaviour.

3.2. Higher education institutes

3.2.1. The university sector: actor setting and international positioning

In Sweden, aside from large private-sector corporations, universities are the main R&D actors. The vast majority of publicly funded research takes place at some 40 universities and university colleges. Several are well placed in international university rankings and dominate university-based R&D. Five universities (Karolinska Institutet, Uppsala University, Lund University, Stockholm University and the University of Gothenburg) receive almost 60% of total public R&D funds.

A variety of higher education institutes: strong traditional and upcoming actors

Some 50 higher education institutes (HEIs) provide a variety of higher education offerings, and about half grant PhDs. In 2011 there were 370 000 first- and second-cycle students (Bachelor's and Master's study programmes) and 18 000 PhD students in higher education and 63 500 degrees were granted. While the vast majority of Swedish universities, university colleges, academies or institutes are public (36 in 2012), there are about ten independent private or semi-private institutes, such as Chalmers University of Technology in Gothenburg (founded in 1829), the Stockholm School of Economics (founded in 1909), or Jönköping University Foundation (founded in 1977). The country that is responsible for establishing and awarding the Nobel Prizes regularly receives high scores on various university-related indicators and in international comparisons and devotes significant amounts of money to higher education. It clearly places high priority on university-based fundamental scientific research.

The Swedish university system dates from 1477 and the foundation of Uppsala University, the oldest university in the Nordic countries. Today it has an enrolment of 26 000[7] first- and second-cycle students, 1 800 PhD students and 4 000 full-time equivalent (FTE) teaching and research staff, of whom 600 full professors. In 2012 the university had nine faculties in three disciplinary areas: arts and social sciences with six faculties, medicine and pharmacy with two faculties, and science and technology with one faculty. It offers 60 Bachelor's and 50 Master's programmes and confers 4 800 degrees a year.

Lund University was founded in 1666. It has eight faculties and many institutes and research centres. It has 32 000 first- and second-cycle students, 2 500 PhD students and 5 000 FTE teaching and research staff, and offers 75 educational programmes at the Bachelor level and about 210 at the Master level. About half of the courses at the Master's level are taught in English. It grants 5 200 degrees a year. Two of the largest research facilities in Sweden, the Max-Lab IV (Ljungberg *et al*., 2009) and the European Spallation Source (ESS), will be built in Lund to support top scientific research in materials and life sciences as well as industrial development. The Faculty of Engineering, Lunds Tekniska Högskola, was founded in 1961 as an independent institute but today belongs to Lund University and is one of Sweden's few complete engineering faculties with about 7 000 students and 1 400 employees.

While the two oldest Swedish higher education institutes are internationally well-regarded comprehensive universities, the Karolinska Institutet, founded in 1810 as an "academy for the training of skilled army surgeons" (Karolinska Institutet, 2012), is Sweden's top medical university. It enjoys a high reputation worldwide and accounts for over 40% of the medical research conducted at Swedish universities. It has 3 600 FTE teaching and research staff and educates 7 300 first- and second-cycle students enrolled in 15 programmes and 2 200 PhD students. It grants 2 500 degrees a year. Research at Karolinska

Institutet spans the entire medical field and is conducted in 22 departments, mostly situated adjacent to Stockholm's teaching hospitals. The Nobel Assembly at Karolinska Institutet is responsible for the selection of Nobel laureates in Physiology or Medicine.

Sweden's two major technical universities with a strong international reputation are the state-owned Royal Institute of Technology (Kungliga Tekniska Högskolan, KTH, founded in 1827) in Stockholm and the independent Chalmers University of Technology (Box 3.4). Chalmers has 17 departments on two campuses in Gothenburg, with a research and teaching staff of 1 800 FTE in 200 research groups, 9 500 first- and second-cycle students, and 1 100 PhD students. Chalmers offers 40 Master's programmes in various science and engineering fields and grants 2 300 degrees a year. It focuses on sustainability, innovation and education in basic and applied sciences. KTH has ten schools and 2 400 FTE teaching and research staff, and a third of Sweden's university-level technical research and engineering capacity. Around 15 000 first- and second-cycle students and about 1 800 PhD students are enrolled in one of nine Bachelor's of Science in Engineering and 16 Master's of Science in Engineering or in a variety of other shorter programmes. KTH grants 2 600 degrees a year ranging from Bachelor to Master to licentiate and doctorate.

Box 3.4. Chalmers University of Technology: An entrepreneurial university in Sweden

Chalmers University of Technology views itself as an *entrepreneurial university*. It is of special interest in the Swedish university system, since it started as a private industrial school in 1829 with a strong scientific orientation. In 1937, Chalmers was absorbed into the Swedish state-owned system but then opted out in 1994 to become a private foundation university but still received public university funding. To help jump-start structural changes, the Swedish government provided Chalmers with a loan that was instrumental in starting various spin-off activities.

Clark (2007) analyses the factors that led to this new autonomy for appointing and rewarding personnel, allocating resources, devising programmes and collaborating with business. Beginning in the late 1970s, the "academic heartland" (p. 88) and the central administration at Chalmers started activities to strengthen entrepreneurship and innovation with a Chair in Innovation Engineering and the Chalmers Innovation Centre around which an infrastructure for transfers from university to industry and *vice versa* evolved in the following decades. The "developmental periphery" (p. 88) ranges from incubators to spin-off companies, from commitment to innovative behaviour to special innovation courses, from industrial contact groups to a major science park adjacent to the campus. Chalmers was well prepared to receive NUTEK funding for 6 out of 30 Swedish competence centres with strong industry involvement at the beginning of the 1990s.

Two features that developed early and show more commitment to Chalmers than to other Swedish universities were its strong alumni relations and fundraising campaigns. The "Chalmers spirit" welcomed the 1991 Swedish government initiative to give state-controlled universities a "foundation" status. While all comprehensive universities opposed this idea, Chalmers succeeded in obtaining this status over the Royal Institute of Technology. Almost two decades later the change is still seen as a success (Jacob *et al*., 2003).

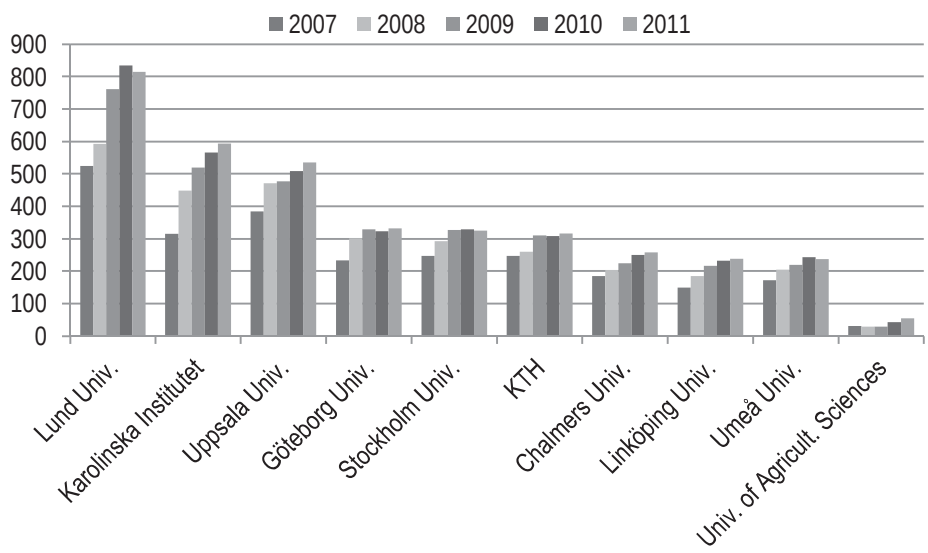
Lindholm Dahlstrand *et al*. (2010) reveal that 42% of the alumni of the Chalmers School of Entrepreneurship (started in 1997) start businesses. Åstebro *et al*. (2012) conclude that "transforming university goals and practices toward increasing start-ups led by faculty might not be the most effective way for universities to stimulate entrepreneurial economic development" but note that "the gross flow of start-ups by recently graduated students with an undergraduate degree in science or engineering is at least an order of magnitude larger than the spin-offs by their faculty, that a recent graduate is twice as likely as her Professor to start a business within three years of graduation, and that the graduates' spin-offs are not of low quality". Since the start of the Chalmers School of Entrepreneurship in 1997 – the first of its kind in Sweden – about 50 new companies have been created in which former students work as CEOs or hold other key positions. Åstebro *et al*. (2012) consider that the Chalmers approach shows that "to create a two-sided market for entrepreneurial talent and inventions and let students and university inventors match up to commercialize university inventions" might be a good alternative to traditional governance, when "the modal number of spin-offs from the top-100 U.S. research universities is zero", especially since "in a jurisdiction with the *Professor's Privilege*, such as in Sweden, the Chalmers arrangement poses no administrative difficulties".

Two other major research universities in Sweden are Stockholm University (founded in 1878) and the University of Gothenburg (founded in 1891). Stockholm University was founded as a university college and became a university in 1960. Today it is the largest Swedish university in terms of number of students, with more than 36 000 first- and second-cycle students and 1 500 PhD students. It has 3 400 FTE teaching and research staff, of whom 500 are full professors, and its four faculties – social sciences, humanities, law and science – are organised into 69 departments and centres. It offers 200 study programmes with roughly half of the Master's programmes offered in English. It awards 4 700 degrees a year. In 1889, Stockholm University appointed Sofia Kovalevskaya, the first woman to a hold full professorship in northern Europe, to a chair in mathematics. She was third female university professor in Europe.

The University of Gothenburg is located in Sweden's second largest city. With approximately 33 000 first- and second-cycle students, 1 600 PhD students, and a teaching and research staff of about 4 200 FTE of whom about 500 full professors, it is one of Sweden's large, wide-ranging universities. It awards 5 100 degrees a year. With 40 departments in nine faculty areas, it covers research and teaching in pharmacy, medicine, odontology and health care sciences; natural sciences; arts and humanities; fine, applied and performing arts; social sciences; business, economics and law; education; information technology; and teacher education.

Figure 3.6. Swedish Research Council support broken down by university

SEK millions



Source: Carlstedt *et al*. (2012), p. 17 and pp. 54 *ff.*

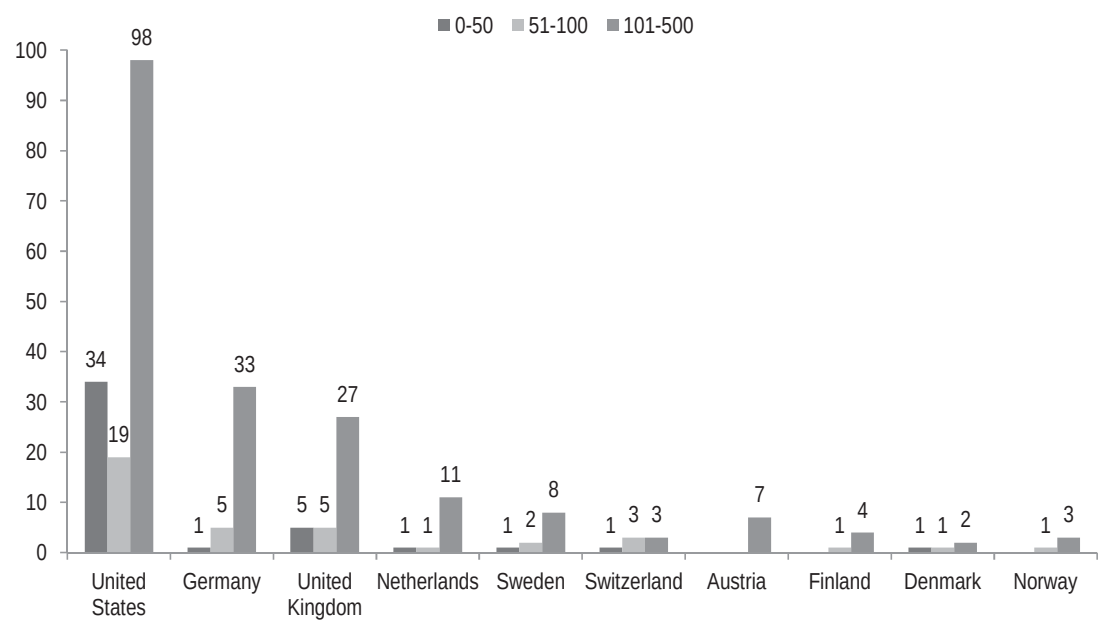
Box 3.5. Swedish university performance in various university rankings

In the *Times Higher Education World University Ranking 2011-2012*, Sweden has five universities among the top 200: Karolinska Institutet rank 32, Lund University rank 80, Uppsala University rank 87, Stockholm University rank 131, and the KTH Royal Institute of Technology rank 187. In comparison, Germany has twelve, Switzerland seven, France five, Denmark three, and Austria one. The ranking is dominated by universities in the United States and the United Kingdom with 75 and 32 universities, respectively, among the top 200. The United States has 30 universities among the top 50. The first non-US, non-UK university is ETH Zurich, rank 15.

In 2012, The *Times Higher Education Supplement* presented its first ranking of the top 100 universities under 50 years old (Times Higher Education, 2012). It includes three "young" Swedish universities: Umeå University rank 23, the Swedish University of Agricultural Sciences rank 27, and Linköping University rank 59. Switzerland has only EPFL (founded in 1968) as runner-up to Pohang University of Science and Technology (founded in 1986) in Korea, which takes first place. Germany has four universities among the top 50 and Austria one. France has four among the top 75 and Denmark two. The United Kingdom has an astonishing 20 universities and the United States nine. Among the top 20 universities under 50, eleven are in Europe, six are in East Asia (three among the top five), and three in the United States.

According to the Shanghai Jiao Tong ranking 2011, Sweden has 11 universities among the top 500, slightly less than 13 for the Netherlands but more than Switzerland with seven. All three countries only have one university each among the top 50 worldwide. In the Netherlands it is a comprehensive university, Utrecht University, rank 48, in Sweden it is a medical university, the Karolinska Institutet, in Switzerland it is a technical university, the Swiss Federal Institute of Technology in Zurich. The absolute numbers for Sweden show a strong university field (Figure 3.7). An interesting comparison is Shanghai performance as a percentage of US GDP per capita. Country performance compared to similar benchmark nations is excellent, with good representation in the top 50 group and very strong performance in the top-100, top-200 and top-500 tiers. However, Switzerland is in a class of its own (Aghion *et al*., 2008, p. 26).

Figure 3.7. Number of top universities in top 500 according to the Shanghai Jiao Tong ranking 2011



Source: *www.shanghairanking.com/ARWU2011.html*. Figure courtesy of Janger *et al*. (2012), p.43, Abb. 15.

The Swedish Research Council (VR, *Vetenskapsrådet*) is Sweden's largest financier of basic research on a competitive peer review basis with an annual budget of around SEK 4 billion (see Chapter 4). If success in receiving such funding is a measure of fundamental research capacity (Figure 3.6), the traditional universities described above dominate. However, Umeå University (founded in 1965), Linköping University (founded in 1969/75) and, to some extent, the Swedish University of Agricultural Sciences (founded in 1977) also have strengths in basic science. While the other public universities are under the Ministry of Education and Research, the University of Agricultural Sciences is the only university under the Ministry of Agriculture, Food and Consumer Affairs. The implicit stratification of the university system in terms of fundamental research capacity is apparent in the pattern of scientific publications. Ten Swedish universities listed among the top European research universities according to an EU survey account for 78% of all Swedish scientific publications, the highest concentration in Europe (European Commission, 2011, p. 165). Another indicator of stratification is provided by the various global rankings of universities (see Box 3.5) which regularly include a handful of Swedish institutes.

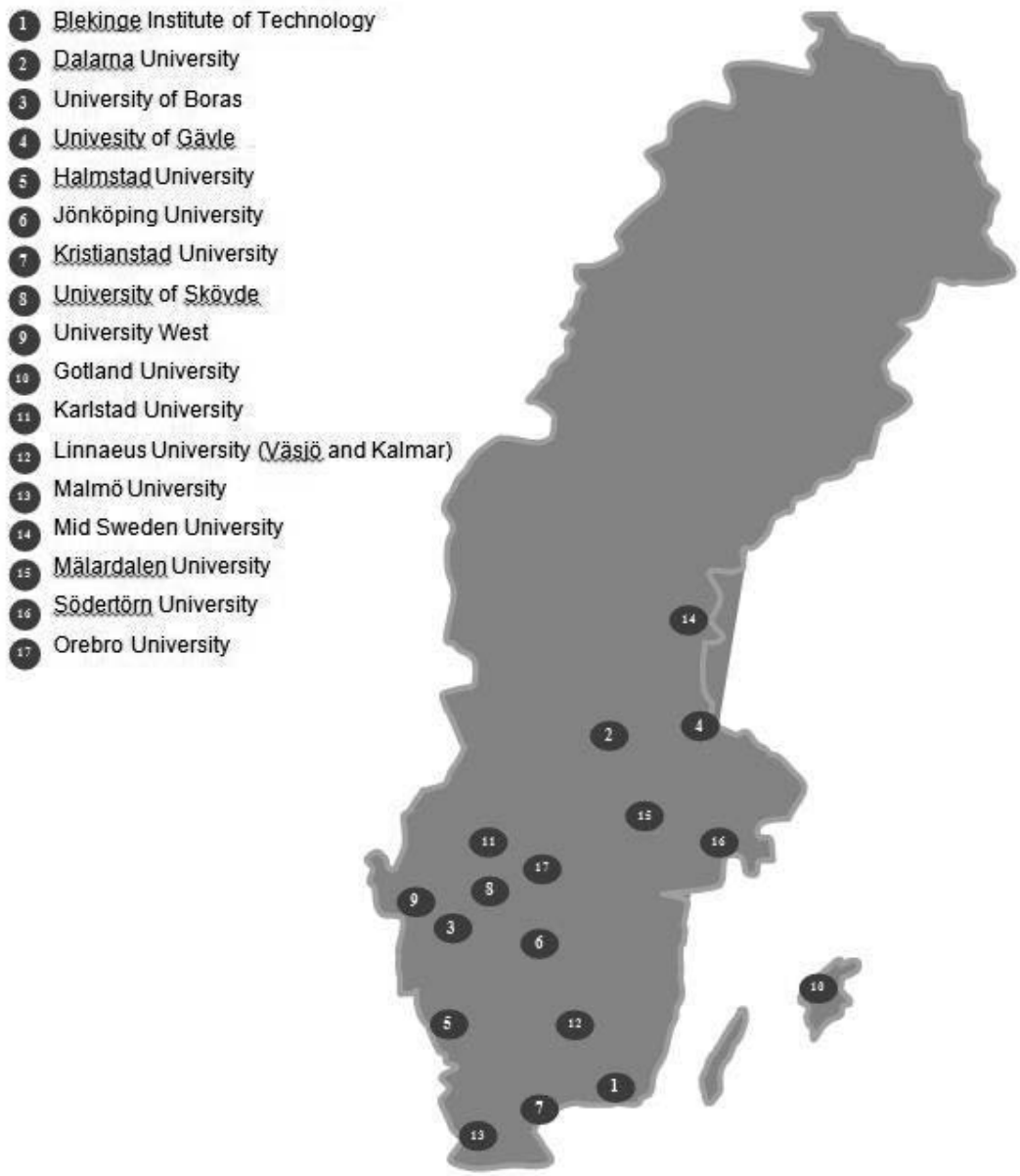
Variety continues: regionalisation of the Swedish higher education system

Sweden was one of the European forerunners in transforming higher education from elite to mass education, having started the process in the 1950s and 1960s. New institutes were founded and the number of students in higher education increased from about 143 000 in 1991 to 257 000 in 2000 (Fägerlind and Strömqvist, 2004, p. 218) and to 385 000 in 2011 (Inkinen, 2011, pp. 49-51). The term "mass education" should in some cases be taken literally, as one professor in many young universities has to deal with an enormous number of students (Ljungberg *et al*., 2009, p. 143).[8]

Since the mid-1970s, the Swedish higher education system has become more regionalised. New universities and university colleges were established, and today, in a country with a large area and a small population, most of the larger and medium-sized cities are home to a university and every county has at least a university college. The Swedish regionalisation process resulted in 17 "new" universities spread around the country (Figure 3.8). While initially their main focus was teaching, they were assigned a research role in the 1980s and in the last decades an increasing number have become universities. The Knowledge Foundation (KK-stiftelsen, KKS) finances research in regional universities to build up research capacity, with mutual benefits for academia and business, and to stimulate business growth through joint scientific-industrial R&D (see Chapter 4). With the support of the KKS, new universities can also gain the right to grant PhD degrees in fields in which they have demonstrated the ability to perform quality research. Nevertheless, many regional universities focus more on teaching and regional development than on scientific research. In recent years some regional universities in the south, west and east of Sweden have merged or are about to merge or to collaborate more closely with traditional universities. This is because some lack critical mass or may face problems as future student cohorts decline.

According to Kaiserfeld (2005), the regionalisation of knowledge raised regional production in Sweden but it has yet to be shown that it also raised regional productivity through knowledge transfer and exploitation. While from an education perspective regionalisation allowed Sweden to accommodate increasing student enrolments, the impact of the newer regional higher education institutions is less clear from an R&D perspective. As a result, the function of regional universities and university colleges as drivers of regional innovation systems is still somewhat unclear.

Figure 3.8. The 17 Swedish universities resulting from the regionalisation process



Source: Heldmark (2010), p. 8.

3.2.2. Inputs to the university system

Financing of universities

Research at Swedish universities is mainly financed by the state through non-competitive block grants. In 2011 the Ministry for Education and Research (MER) allocated SEK 14 billion in block grant funding for university research. The Research and Innovation Bill 2009-12 initiated a certain degree of performance-based funding to this allocation, although it applies to a small fraction of the total block grant funding for research (Box 3.6). Additional public funding for universities comes through the three research councils VR, Formas and FAS (described in Chapter 4) which distributed about

SEK 5.9 billion on a competitive basis in 2011, mostly to universities (Growth Analysis, 2011). In addition, universities receive funding from other agencies or foundations, such as SSF, VINNOVA and KKS. The universities have also been the main beneficiaries of direct grants made available for 24 strategic areas in which Swedish scientific research is of high quality and of high relevance for society and business.

Box 3.6. The introduction of performance based funding at Swedish universities and colleges

Until 2009, state research resources directly paid to universities and colleges as block grants were distributed according to historically established criteria among the 38 institutes. In 2008, the Brändström study proposed a new form of financing involving performance-based criteria (Jongbloed, 2009, p. 45). This was taken up in the 2009-12 Research and Innovation Bill (Swedish Government, 2008, p. 23 and pp. 51-67 for more details). Under the new arrangements, the Swedish government announced it would withdraw 10% of all university block grants for R&D and would distribute them together with an additional 10% based on quality indicators with a view to increasing the relevance and competitiveness of university research. The indicators include the fraction of third-party funding of R&D (weight factor of 50%), the number of publications (weight factor of 25%) and the number of citations (weight index 25%). Assessments are made on a yearly basis at the level of the university or university college. This new model for the assignment of research funds is supposed to create incentives for universities and colleges to favour the research areas in which excellent research is already being performed and in which they are able to compete internationally and create a clear and competitive research profile (Swedish Government, 2008, p. 23).

The United Kingdom introduced in 1986 the first such system, which was much more comprehensive, called the *Research Assessment Exercise* (RAE, to be replaced by REF, *Research Excellence Framework*, in 2014). Currently, countries such as Australia, New Zealand, Hong Kong (China) and Norway also assign research funds on the basis of universities' international performance (Flodström, 2010, p. 49ff).

The Swedish model is still under evaluation and remains somewhat controversial within the scientific community (Flodström, 2010, p. 26). The Swedish science funding agencies, as well as SULF, the Swedish Association of University Teachers, are also not (fully) satisfied with the implementation of this new system and the suggestions made in the report (Flodström, 2010).[1] It is therefore likely to undergo changes in the coming years. For instance, the issue of whether suggested peer-reviewed evaluation of selected research areas (Swedish Government 2008, p. 51 *ff*.) should be adopted still has to be discussed.

1. VINNOVA (2012); SULF (2012).

After a decade of stagnation and as a direct response to the financial crisis of 2008, the Swedish university budget has been increased considerably. Around one-third of the increase is allocated as a block grant without any conditions, another third for a number of areas of special interest to society and industry and a third for research infrastructure and industry-related research. Two recent major government investments in research infrastructure are the European Spallation Source (ESS) in Lund and the Science for Life Laboratory (SciLifeLab) in the Stockholm and Uppsala region.

In international comparison, Swedish higher education expenditure on R&D (HERD), at 0.9% of GDP, is around twice the OECD and the EU27 average. Only Denmark has similar levels of expenditure (Table 3.8). Comparator countries such as Austria, Finland, the Netherlands, and Switzerland average about 0.75% of GDP, while bigger nations such as Germany and the United Kingdom are well below that level at about 0.5% of GDP.

Table 3.8. Higher education expenditure on R&D (HERD) as a percentage of GDP

	2000	2005	2006	2007	2008	2009	2010
Austria	..	0.61	0.59	0.60	0.67	0.71	0.72
Canada	0.54	0.69	0.66	0.67	0.68	0.72	0.69
China	0.08	0.13	0.13	0.12	0.12	0.14	..
Denmark	0.45	0.60	0.64	0.68	0.77	0.90	0.90
Finland	0.60	0.66	0.65	0.65	0.64	0.74	0.79
France	0.40	0.40	0.40	0.41	0.43	0.47	0.48
Germany	0.40	0.41	0.41	0.41	0.45	0.50	0.51
Israel	0.65	0.64	0.65	0.61	0.64	0.59	0.58
Italy	0.32	0.33	0.34	0.35	0.37	0.38	0.36
Japan	0.44	0.45	0.43	0.43	0.40	0.45	..
Korea	0.26	0.28	0.30	0.34	0.37	0.39	0.40
Netherlands	0.62	0.66	0.64	0.63	0.67	0.73	0.75
Norway	..	0.46	0.45	0.51	0.51	0.57	0.55
Sweden	**..**	**0.78**	**0.76**	**0.75**	**0.79**	**0.91**	**0.90**
Switzerland	0.58	..	0.66	..	0.72	..	..
United Kingdom	0.37	0.44	0.46	0.46	0.47	0.52	0.48
United States	0.31	0.36	0.35	0.35	0.36	0.39	..
Total OECD	**0.35**	**0.39**	**0.39**	**0.39**	**0.40**	**0.44**	**..**
EU27	0.37	0.39	0.40	0.40	0.43	0.47	0.47

Source: OECD Main Science and Technology Indicators 2012/1, p. 69.

Direct government funding for teaching of first- and second-cycle courses at Swedish universities is allocated according to a number of indicators, including number of degrees per discipline, number of students per discipline or special assignments. Each main discipline has a certain monetary value. There is an overall ceiling and higher education institutes are free to distribute the lump sums as they choose (Jongbloed, 2009, p. 44, for an overview). A funding cap set annually by the government for each HEI which determines the upper limit that can be paid to a HEI (Inkinen, 2011, p. 17). This system is complemented by a centralised student selection system (Aghion *et al*., 2008, p. 14). Swedish universities in general do not own their buildings, which are administered by a central public agency (Estermann and Nokkala, 2009, p. 25).

Researchers in higher education

Table 3.9 shows the share of higher education researchers in the national total of researchers for selected countries. Roughly one-third of Swedish researchers are employed in higher education, a share comparable to that in many other countries. The share of higher education researchers increased from 27.5% in 2005 to 34.4% in 2010. Denmark is the only comparator country with available data that showed a similar increase over the period, but this includes the results of mergers of research institutes into universities. In FTE terms, 15 000 researchers worked in HEIs in 2005 and 17 000 in 2010.

Table 3.9. Higher education researchers as a percentage of the national total (full-time equivalents)

	2000	2005	2006	2007	2008	2009	2010
Austria	..	31.5	31.7	31.9	31.9	32.5	32.5
Canada	30.8	31.7	30.9	31.7	33.1	..	..
China	21.3	19.8	19.3	17.4	16.4	19.5	..
Denmark	..	29.2	30.4	32.0	30.7	34.4	35.5
Finland	31.6	32.5	31.8	31.2	29.0	30.1	32.7
France	35.8	32.7	32.3	30.4	30.1	29.3	..
Germany	26.0	24.0	24.0	25.1	25.4	26.7	27.4
Israel	..	..	..	..	..	..	..
Italy	38.9	44.9	42.6	41.8	..	42.3	41.1
Japan	27.7	22.9	23.3	23.3	18.8	19.0	..
Korea	21.8	15.2	14.2	16.9	14.7	15.6	14.9
Netherlands	36.9	37.5	33.9	35.5	37.1	41.9	38.8
Norway	..	35.4	34.9	34.8	34.3	34.9	35.7
Sweden	**..**	**27.5**	**26.4**	**32.5**	**29.7**	**34.7**	**34.4**
Switzerland	36.1	..	..	..	57.0	..	..
United Kingdom	..	57.0	58.0	59.6	60.6	61.7	60.6
United States	..	..	..	..	..	..	..
Total OECD	**..**	**..**	**27.5**	**..**	**..**	**..**	**..**
EU-27	36.9	40.1	39.8	40.1	40.5	41.4	41.4

Source: OECD Main Science and Technology Indicators 2012/1, p. 73.

Academic career norms and incentives appear to favour those who stay in place and accumulate external funding. Well-developed career programmes beyond post-doc stages and career tracks for younger people are reported to be rare. There is therefore little mobility. In a ten-country comparison, Sweden ranked third at 58% in terms of the percentage of faculty members with a PhD degree from their employing higher education institute. Only Spain and Belgium ranked higher, with 69% and 63%, respectively. Comparator countries show much higher levels of mobility: for example, home-grown faculty were only 24% in Switzerland, 33% in the Netherlands and 40% in Denmark. Larger countries, such as the United Kingdom and Germany, have high levels of academic mobility with only 8% of home-grown faculty (Aghion *et al*., 2008, pp. 36 and 38). The relative lack of mobility in Swedish universities may indicate a lack of dynamism in the sector.

Recent bibliometric analysis of the "recruitment" (in the general sense of having them rather than in the strict sense of formally hiring them) of top performers among university faculty is perhaps an even greater cause for concern. Comparing Sweden to other leading science countries, Karlsson and Persson (2012) show that Sweden has relatively low rates of elite author recruitment. Table 3.10 presents part of their results over three partially overlapping time periods corresponding to the years 1986-2000, 1991-2000 and 1996-2010. Among the comparator group of countries Sweden experienced the lowest recruitment rate over the first period and came second-last in the two following periods (Table 3.10). Sweden also comes second-last in terms of growth rates of total publication volume and of the size of the elite author community (Karlsson and Persson, 2012).

Table 3.10. Recruitment rates in six countries

Percentage of elite authors emerging during the last five years of a 15-year period

Country	Period			Mean growth of publication volume	Mean growth of no. of authors, 1986-2010
	1986-2000	1991-2005	1996-2010		
Denmark	8.1	5.3	5.0	2.8	5.9
Finland	7.7	4.0	3.1	3.2	6.2
Netherlands	9.5	6.5	5.2	3.5	6.1
Sweden	**5.4**	**4.4**	**3.7**	**1.9**	**5.2**
Switzerland	10.6	6.3	7.7	3.0	6.3
United Kingdom	6.6	4.7	4.8	1.4	4.5

Source: Karlsson and Persson (2012).

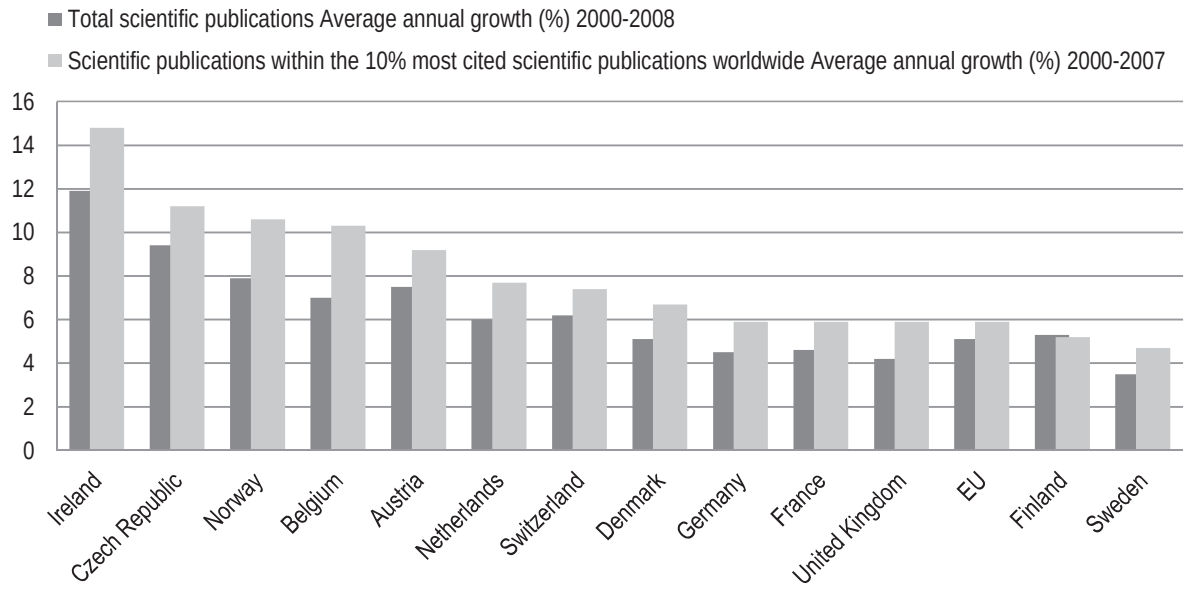
3.2.3. Research output, impact and success

Ideally, large expenditures result in equally large outputs and impacts. This section examines various indicators to explore the extent to which the Swedish university system, particularly its traditional, well-endowed universities, performs compared to countries with top outputs, such as Switzerland. For this comparison, publication and citation data are used together with data on Sweden's performance in attracting European excellence funding.

Publications and citations

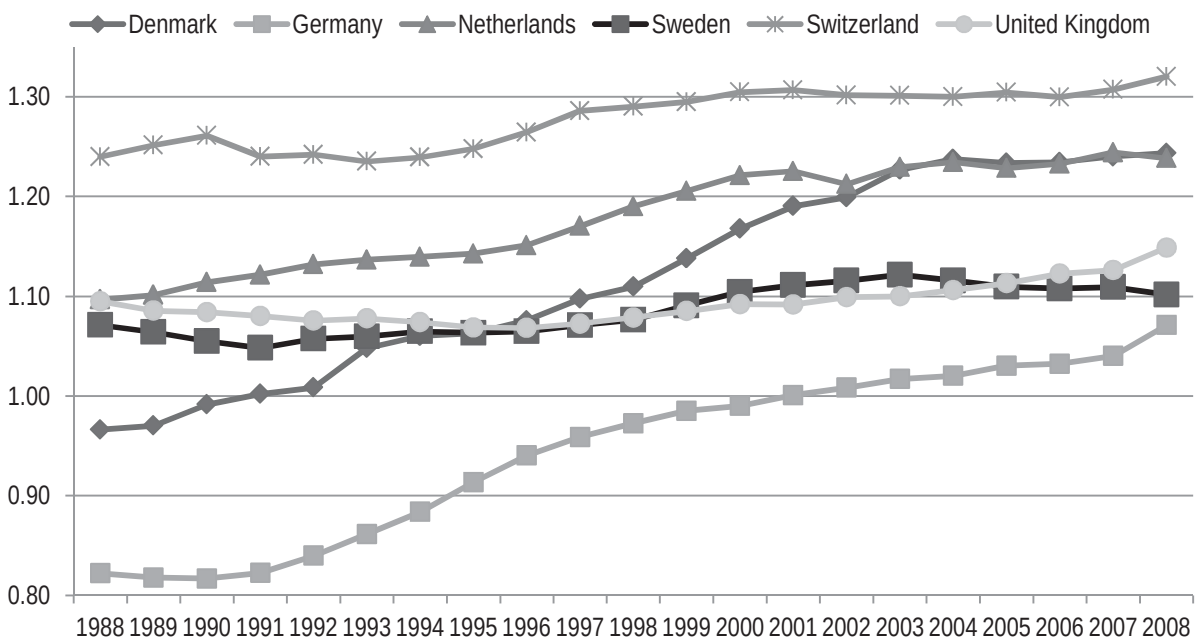
Overall the Swedish research system has a good publication record and compares well internationally in terms of scientific publications per 1 000 inhabitants (see Chapter 2). The scientific community is internationally well connected and international scientific co-publication patterns are stronger than in a number of comparator countries (Growth Analysis, 2011, p. 40). However, Sweden's 3.5% average annual growth in total scientific publications for 2000-08 is comparatively low and below the 5.1% EU27 average (Figure 3.9). More worrying still is the impact of research, as measured by citations. Compared to high-performing benchmark countries and to the large input into the system, the share of publication output that is highly cited is not very impressive (Figure 3.10). For the 10% most-cited scientific publications as a percentage of total scientific publications, Sweden has stagnated on a mid-level compared to other countries. Growth in Germany and Austria have brought them to a position very close to Sweden's, and the Netherlands, Denmark and Switzerland have increased their advantage over Sweden (Figure 3.11). This can be interpreted as a loss of scientific competitiveness.

Figure 3.9. Average annual growth rate in scientific articles and the 10% most cited articles



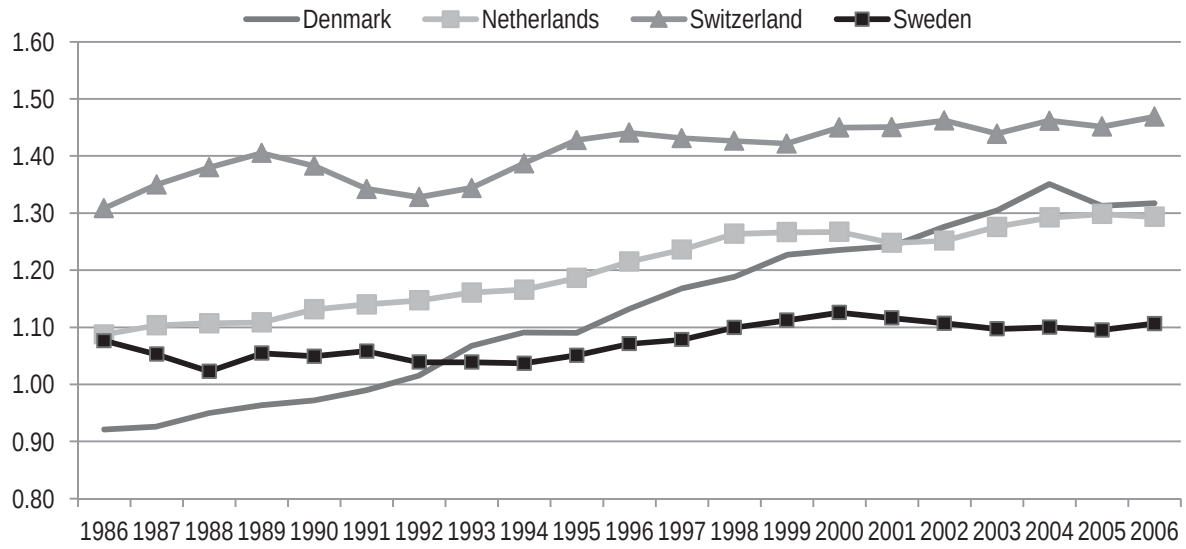
Source: European Commission (2011), p.139.

Figure 3.10. Field-adjusted citations for selected countries, 1988-2008



Source: Growth Analysis (2011, p. 56), based on Vetenskapsradet (2010)

Figure 3.11. Field-adjusted citation frequency in relation to top 10% most cited publications for selected countries, 1986-2006



Source: Growth Analysis (2011), p. 57, based on Vetenskapsradet data (2010).

Furthermore, Swedish universities have a relatively small share of highly successful subject fields. They also yield comparatively few top publications (see Bonaccorsi, 2007, pp. 305 *ff*.). One of the main features here is the strong reliance on biomedicine, including clinical research, which accounts for half of the Swedish publication volume but has a declining relative impact and generally lacks dynamism. Table 3.11, drawing on the findings of Karlsson and Persson (2012), shows the share of papers published in prestigious journals during 2005-09, as a proportion within three broad subject profiles (Medicine, Natural Science and Other) and as a proportion of total volume and of citations. First, the table figures confirm the dominance of the broader field of medicine. Second, Sweden has the second largest share of papers appearing in prestige-journals, after Switzerland. Third, and notably, prestige-journal citations account for a smaller share of total citations than most other countries in the group, with the exception of Finland.

Table 3.11. Subject profile for papers in prestige-journals, 2005-09

Country	Subject profile			Volume	Citations
	Medicine	Natural science	Other		
Denmark	54%	38%	8%	0.46%	2.2%
Finland	62%	32%	6%	0.27%	1.3%
Netherlands	56%	34%	10%	0.42%	1.8%
Sweden	71%	23%	6%	**0.55%**	**1.9%**
Switzerland	63%	29%	8%	0.80%	3.4%
United Kingdom	54%	31%	14%	0.62%	2.5%

Source: Karlsson and Persson (2012).

A further question is whether Swedish universities tend to build critical mass. It is difficult to answer because it is difficult to make internationally valid comparisons. A study from the mid-2000s shows that the universities of Lund, Uppsala, Gothenburg and Stockholm as well as the Karolinska Institutet show some concentration effects: they have larger numbers of senior researchers active in the same field in a larger number of fields (*i.e.* "high density across research subjects", Ljungberg *et al*., 2009, pp. 145 *ff*.). However, lack of context and difficulties for defining fields and density make comparisons difficult.

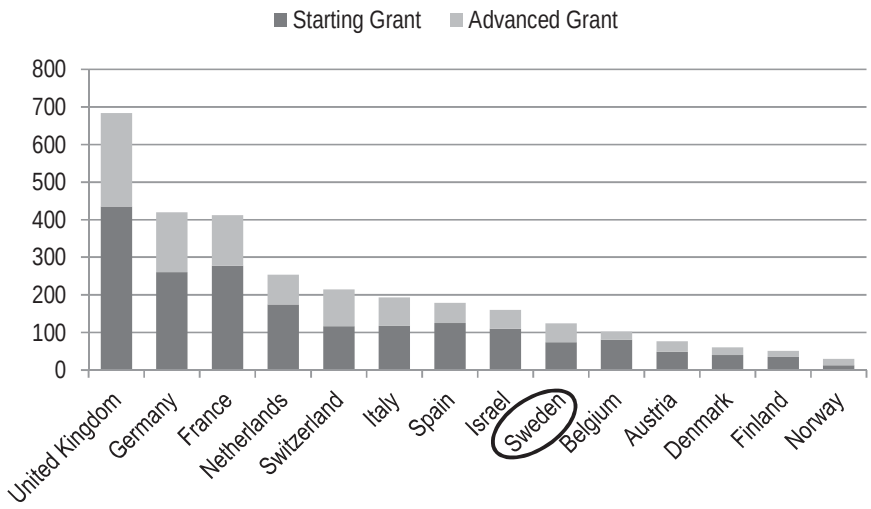
The European Research Council and its funding of frontier research in Sweden

The European counterpart to the Swedish Research Council is the European Research Council (ERC), established under the EU 7th Framework Programme (FP7), which has 15% of the overall FP7 budget, *i.e.* EUR 7.5 billion during 2007-13. The ERC supports excellence in frontier research in all fields of science through pan-European competition by individual researchers for significant funding of bottom-up research projects. The two major grants are the ERC Starting Grants and the ERC Advanced Grants. The former target promising, up-and-coming researchers with proven potential of becoming independent research leaders. The latter allow exceptional established research leaders of any nationality and any age to pursue ground-breaking, high-risk projects that open new directions in their respective research fields or domains. Recent findings (Edler *et al.*, 2012) show that the ERC has already had a certain impact on universities, including recognition as a new quality indicator across Europe.

In the ERC calls during 2007-12, researchers working at Swedish host institutes received 74 Starting Grants and 50 Advanced Grants. The success rate of around 9% during 2007-11 is comparable to the EU average but is lower than that of Belgium, Germany, the Netherlands, Austria, the United Kingdom, France and Israel, all of which range between 10% and 16%. Switzerland is in a class of its own, with a success rate of 22%. One possible explanation for Sweden's average performance might be the high numbers of applications from Swedish researchers: one out of 14 public researchers submitted an ERC application in 2007-11, a figure nearly twice the number for comparator countries.

In terms of the number of grants (Figure 3.12) Sweden has a good record in relation to the size of the country, better than Denmark, Austria and Finland, but is outperformed by Switzerland and the Netherlands (and by Israel). Per million population, Switzerland leads with 24 grants, followed by Israel with 19, the Netherlands with 12 and Sweden with 11. The balance between starting and advanced grantees varies from country to country, though Sweden scores well in both categories. Given the high inputs into the university system, this record is good but not first-rate. Why Swedish researchers are less successful than academics working in the strongest of the (small) countries eligible for ERC funding should be further investigated.

Figure 3.12. Distribution of ERC Starting and Advanced Grants, 2007-12



Source: ERC data information, September 2012.

In a university ranking of grantees (Table 3.12) 25 European and 3 Israeli universities hosted at least 16 ERC grantees from the eight starting and advanced grant calls during 2007-11. These 28 research institutes received almost one-third of the grants, *i.e.* 809 out of 2 556. Six are located in the United Kingdom, six in the Netherlands, four in Switzerland, three in Israel, two each in Denmark, Germany and Sweden and one each in Austria, Belgium and Finland. The two Swedish universities are the Karolinska Institutet with 20 grantees (18th position) and Lund University with 16 (28th position), *i.e.* the same universities that lead in funding from the Swedish Research Council (see Figure 3.6 above). These two Swedish universities host more than one-third of the 100 or so ERC grantees in Sweden.

The European Institute of Technology and Swedish university participation

Another recent introduction to the EU funding landscape is the European Institute of Technology (EIT) established in 2008. Originally foreseen as the European counterpart to the Massachusetts Institute of Technology (MIT) in the United States, the EIT did not become a single science and engineering institute but operates through knowledge and innovation communities (KICs) in co-location centres across Europe. They link higher education, research and business to train a new generation of innovators and entrepreneurs. In a first funding round in 2009, three KICs were selected; Sweden hosts the co-location centres for two of them, the EIT ICT Labs and the KIC InnoEnergy.

The Swedish EIT ICT Labs node in Stockholm comprises three core partners, KTH, Ericsson AB and the SICS research institute, and several affiliated partners, including Lund University and Luleå University of Technology. The Swedish KIC InnoEnergy node is in Stockholm and Uppsala. The four core partners are KTH, Uppsala University, ABB and Vattenfall. It receives one-sixth of the KICs funding to develop smart grids and energy storage. Participation in the EIT has been a government priority in Sweden with strong support and encouragement for Swedish participation in applications. While this commitment clearly paid off in the short term, it is too early to assess its long-term strategic impact.

Table 3.12. Top 28 European universities hosting at least 16 ERC grantees, by funding scheme

Country	Higher-education institution	StG	AdG	Total
United Kingdom	University of Cambridge	44	32	76
United Kingdom	University of Oxford	38	34	72
Switzerland	Swiss Federal Institute of Technology Lausanne	27	25	52
Israel	Hebrew University of Jerusalem	28	17	45
Switzerland	ETH Zurich	14	29	43
United Kingdom	University College London	23	19	42
United Kingdom	Imperial College	22	20	42
Israel	Weizmann Institute	21	18	39
Belgium	University of Leuven	19	7	26
United Kingdom	University of Bristol	9	15	24
Germany	University of Munich	8	15	23
Netherlands	Leiden University	12	11	23
Switzerland	University of Zurich	10	13	23
United Kingdom	University of Edinburgh	11	12	23
Finland	University of Helsinki	12	9	21
Netherlands	University of Amsterdam	13	8	21
Israel	Technion	17	3	20
Sweden	**Karolinska Institutet**	**11**	**9**	**20**
Netherlands	Free University of Amsterdam	13	6	19
Netherlands	Radboud University Nijmegen	13	6	19
Netherlands	University of Groningen	16	2	18
Denmark	Aarhus University	9	9	18
Austria	University of Vienna	8	9	17
Netherlands	Utrecht University	11	6	17
Switzerland	University of Geneva	6	11	17
Denmark	University of Heidelberg	10	7	17
Denmark	University of Copenhagen	9	7	16
Sweden	**Lund University**	**8**	**8**	**16**

Source: ERC data information, September 2012.

Could Sweden's universities do even better?

In spite of its comparative success in competing for European funding, Sweden's relatively weak performance in citations over the last 20 years is worrying. The stagnation suggested by bibliometric data is not easily explained and is likely influenced by a mix of factors. Karlsson and Persson (2012) note that the most successful countries – Switzerland, the Netherlands and Denmark – do not depend on a few elite institutes for their success. They have strong university systems, with few universities performing below the world average. Another contributing factor could be the relative "endogamy" of the faculty in Sweden's universities and the comparatively weak renewal of the scientific elite. It could also be that the relatively fragmented research funding system – some 20 mid-sized funding organisations with mid-sized instruments – tends to fund good quality but "safe" research (see Chapter 4) which is less likely to be widely cited.

Box 3.7. The Swiss EPFL: An example of the successful evolution of a higher education institute

Switzerland is among the OECD innovation leaders (OECD, 2006). Its higher education and public research system is at the forefront of European performance. It has ten cantonal universities, two federal institutes of technology (ETH Zurich and EPF Lausanne), four federal research institutes and eight universities of applied sciences.

The *École Polytechnique Fédérale de Lausanne* (EPFL) was founded in 1853 as a private technical college and later became part of the University of Lausanne. Since 1969 it is a separate federal institute whose campus is located next to the campus of the University of Lausanne. Together they form the largest research and education centre in Switzerland. EPF Lausanne and ETH Zurich are Switzerland's two technical universities. The ETH system receives substantial general university funds from the federal government and the presidents of the universities have a strong role which includes overall management responsibility and an active part in the hiring of professors. At EPFL, Patrick Aebischer, university president since 2000, has used his strong position to help transform the university by hiring top researchers worldwide and by fostering strong relationships between the academic community and industry.

On the academic side, EPFL integrated mathematics, physics and chemistry from the University of Lausanne, restructured into five schools, each of which manages its own budget, and established a completely new school of life sciences with a strong focus on biomedical engineering, which already had in 2010 about 650 FTE research and teaching staff. At the interface of academia and industry the EPFL campus hosts, in its newly established *Quartier de l'innovation* (Innovation Square), research centres of companies that collaborate scientifically with EPFL in medical technology, biotechnology, green technology or ICT. In 2012 these companies included Logitech, Debiopharm, Cisco, Alcan, Nokia, Crédit Suisse and the Nestlé Institute of Health Sciences. In all EPFL has about 4 400 FTE research and teaching staff. This increasingly international staff educates about 7 700 students to become engineers and scientists. EPFL actively promotes interdisciplinarity at the student level and participates in high-visibility projects such as Solar Impulse or l'Hydroptère[1] to brand the university. The internationalisation strategy of EPFL includes strong agreements with universities in Asia.

In the space of about ten years, EPFL has been transformed from a good engineering school to a world-class technical research university. This is reflected in various rankings; for example, EPFL follows only the universities of Oxford and Cambridge in terms of receipt of ERC Starting Grants and ERC Advanced Grants from the European Research Council (see Table 3.12) and also ranks prominently in international university rankings. In one ranking, EPFL takes second place among the top 100 universities under 50 years of age (Times Higher Education, 2012).

1. EPFL (2012a), EPFL (2012b).

A further possible explanation might be a gap between the level of resources nominally allocated to university research and what is actually spent. For example, Granberg and Jacobsson (2006) argue that Swedish PhD students are very expensive, that block funding is mainly used for teaching and other non-research matters, and that university researchers' time for scientific research has been squeezed out of the system. The authors claim that Swedish universities have fewer person-years engaged in R&D per million inhabitants than their counterparts in a number of other countries (pp. 324 *ff.*, with data for around 2000).[9] Similarly, data from the European Commission (2011, p. 152) suggest that public expenditure on R&D per public-sector researcher has been lower in Sweden than in most other advanced small European countries.[10] However, academic researchers and universities can draw on more than 20 public, semi-public and private foundations for research funding, much of which is excluded in international comparisons.[11] In a ten-country comparison, the average Swedish university can draw on the highest share of competitive research grants relative to overall budget (Aghion *et al.*, 2008, p. 31), and overall university budgets in Sweden are high as well.

Another important consideration is university governance. Individual professors have a strong role in Swedish universities, so that Swedish universities are rather decentralised organisations and their leadership is not comparable to that of some Swiss or American counterparts, where the president or vice–president plays a very strong role. The extremely rich competitive funding landscape, which is a positive feature of the Swedish system, empowers researchers who are able to acquire funds directly. University leadership seems to have limited control over research allocations and much core funding probably tends to follow the pattern of external funding. The governance of universities seems to come from research departments, from many strong individuals and from a chorus of outside (funding and social) organisations, with impacts on recruitment, careers and the development of new fields. This stands in contrast to the strengthening of the formal powers of the leadership since 1993 and the enlarged political and industry representation on university boards (Jongbloed, 2009, p. 42) and to certain formal powers of university leadership for recruiting senior academic staff, as in most European countries (Estermann and Nokkala, 2009, p. 28). Box 3.7 describes the Swiss Federal Institute of Technology in Lausanne, which, through strong leadership, has transformed itself into one of the world's leading universities in a relatively short time.

A recent study of the Royal Swedish Academy of Sciences (Öquist and Benner, 2012) confirms such findings. Based on a comparison with Finland, the Netherlands, Denmark and Switzerland, it identifies weaknesses in the ability of the Swedish academic system to produce sufficient scientific work of high global impact. The study identifies a number of structural problems relating to recruiting top people, safeguarding career tracks, supporting top quality and providing effective academic leadership. Moreover, the generous funding streams include a number of disincentives and do not sufficiently encourage frontier research. In sum, the study finds that the drawbacks of the general university funding (and the internal university allocation) along with too many small multi-goal external funding sources create a situation in which universities become "research hotels", "an effect of the skewed funding and authority structure" (Öquist and Benner, 2012, p. 31).

3.2.4. Third mission and commercialisation

Sweden has long recognised the so-called "third mission" of universities and considered ways to realise the commercial potential of Swedish academic research. Starting with the academic inventors of the late 19th century, academic and industrial research co-evolved over long periods in sectors such as telecommunications and energy. In recent decades, academic researchers have contributed to industrial competitiveness, sometimes very strongly (see Box 3.8), sometimes through (personal) consulting and other forms of non-institutional technology transfer. Nevertheless, on one measure of the relationship between industry and HEIs, *i.e.* the percentage of higher education expenditure on R&D (HERD) financed by industry (Table 3.13), Sweden is below the OECD average of 6.3% and the EU27 average of 6.4% and the percentage has decreased slightly from 5.1% in 2005 to 4.5% in 2009. Germany is clearly the outlier among European comparator countries with 14.3% of HERD financed by industry in 2009, more than twice the OECD average and more than three times Sweden's share.

The third mission of Swedish universities was officially mandated in 1975 and initially realised in terms of communication and strengthening of linkages. The task of disseminating results came in the new university regulation of 1998 (Bourelos *et al*., 2012, pp. 753 *ff*.). In parallel, most universities built up technology transfer offices (TTOs),[12]

incubators and science parks, and universities such as Chalmers developed entrepreneurship schools or courses as part of their overall academic portfolio (Åstebro *et al*., 2012, p. 673). Given these developments, there is little doubt that academic entrepreneurship is an important goal of the Swedish academic sector.

Table 3.13. Percentage of higher education expenditure on R&D financed by industry

	2000	2005	2006	2007	2008	2009	2010
Austria	..	..	5.0	5.7	..	5.2	..
Canada	9.5	8.4	8.4	8.5	8.2	8.2	8.2
China	32.4	36.7	36.6	35.1	34.6	36.7	..
Denmark	2.0	2.4	2.5	2.1	..	3.4	3.4
Finland	5.6	6.5	6.6.	7.0	7.2	6.4	5.7
France	2.7	1.6	1.7	1.6	2.2	1.8	1.8
Germany	11.6	14.1	15.1	15.5	15.1	14.3	..
Israel	3.7	7.3	7.2	7.2	7.2	..	..
Italy	..	1.4	1.2	1.3	1.2	1.1	1.1
Japan	2.5	2.8	2.9	3.0	3.0	2.5	..
Korea	15.9	15.2	13.7	14.2	12.0	11.3	11.3
Netherlands	..	7.8	..	7.5	..	8.2	..
Norway	..	4.7	..	4.0	..	3.8	..
Sweden	**..**	**5.1**	**5.1**	**4.9**	**..**	**4.5**	**..**
Switzerland	5.1	..	8.7	..	6.9	..	..
United Kingdom	7.1	4.6	4.8	4.5	4.6	3.9	4.6
United States	7.1	5.1	5.3	5.6	5.8	6.0	..
Total OECD	**6.4**	**6.1**	**6.3**	**6.6**	**6.4**	**6.3**	**..**
EU27	6.3	6.4	6.7	6.9	6.7	6.4	..

Source: OECD Main Science and Technology Indicators, February 2012.

Box 3.8. The GSM story

The development of mobile phone technology, especially the GSM standard, is a major success of Swedish government research funding which benefited both universities and industry (Arnold *et al*., 2008). From 1975 to 1998 the predecessors of VINNOVA, STU and NUTEK (see Chapter 4) played an important role in building up ICT research capacity at universities and institutes of technology (especially at Lund, Linköping, Chalmers, KTH, Uppsala and Luleå). According to Arnold *et al*. (2008), the research and teaching capacity in digital mobile telephony increased at least ten-fold owing to government stimulus of the digital communication programme. The universities were therefore both enablers and beneficiaries of Ericsson's success. As enablers they supplied well-educated engineers and scientists, and they benefited because applied scientific research and engineering thrive on access to emerging problems.

Box 3.9. "From our pipeline to your bottom line": The YEDA story

Only a few top universities and research organisations across the world have meaningful income from the commercialisation of research. Israel's Weizmann Institute is such an organisation, although it is neither exceptionally big nor can it look back on a long tradition. The Institute was founded in the 1930s in the Israeli countryside, mainly by Chaim Weizmann, without surrounding industries or public infrastructures. In 1949 it was named after the founder, a famous inventor and first president of Israel. The idea behind this stand-alone institute was to establish basic science and advanced learning as an integral part of the new state's development. It grew rapidly and attracted talented people and ample funding from Israel and from around the world. Success factors included concentration on high-quality basic scientific research ("seeking revolutions instead of evolutions"), often at the interface between disciplines, and emphasis on PhD formation. Today the Institute has 50 interdisciplinary centres, around 2 500 employees, including 250 professors and 1 000 mainly doctoral students on a small campus. More than half of the post-docs are not Israeli citizens. It has a number of eminent scientists, including the winner of a Nobel prize, and around 40 ERC grantees. As Table 3.12 shows, Israeli research institutes are highly successful at winning ERC grants. The Weizmann Institute is nearly as successful as the much larger Hebrew University, and both are among the top ten recipients of these grants.

Weizmann representatives emphasise the focus on excellence in basic science and on the following elements: bottom-up approach, curiosity-driven research, "publish or perish", long-term orientation and shielding the Institute from commercial risks. Scientists – many of them live on the campus – are not to be concerned with application and can devote only limited time for activities other than scientific research. A VP for Technology Transfer is part of the executive leadership of the Institute.

YEDA is Weizmann's TTO. It was founded in 1959 – decades before the US Bayh-Dole legislation – and it took several years to deliver returns. The office takes care of identification, application, licensing and protection of all Weizmann IP. Weizmanns' VP for Technology Transfer is YEDA's chairman, and YEDA is to be informed about scientists' inventions. YEDA is the exclusive channel for patenting, commercialisation and protection, and inventors have to co-operate and disclose relevant knowledge. Life sciences are the most important source of patents and revenues. If YEDA does not submit a patent, inventors can try to commercialise their invention on their own but still have to reimburse part of any profits to YEDA. If YEDA decides to patent, they are in full charge of the process and – like nearly all TTOs – focus on licensing contracts, often with Israeli firms. For some, like the pharmaceutical company Teva, Weizmann IP led to the development of blockbusters. Companies such as Adobe or Johnson and Johnson also profit from licence agreements with YEDA. Revenue is distributed as follows: 40% to the scientists, 60% to the Institute (minus a commission for the TTO). Some researchers have become wealthy through these agreements.

YEDA has filed or participated in filing 1 400 patent families, has signed many licensing agreements and established around 50 spin-off companies based on Weizmann knowledge and IP. Currently YEDA owns 660 live patent families. The total annual royalty-generating sales in 2010 amounted to USD 15 billion.

The Weizmann budget is approximately USD 300 million. A third comes from the Israeli government for basic funding, while the rest comes from international donations, international and national competitive funding, and revenues of the Institutes' endowment. YEDA currently contributes USD 15-20 million a year to the Institute's budget, although its contribution was significantly higher in the mid-2000s. YEDA also organises money flows for pre-competitive research from industry to the Institute. A large industrial park next to the Institute hosts a number of successful firms.

A key lesson from Israel's experience is the need to work on a high professional level to commercialise research. All Israeli TTOs have clear missions and top staff. YEDA representatives know what researchers have accomplished and have more than 1 000 industry contacts a year. Another lesson is that academic excellence and commercial success are not incompatible but can be mutually reinforcing. Studies show that there is a strong positive correlation between scientific excellence and the intensity of industry contacts of individual researchers in Sweden (Bourelos *et al.*, 2012, pp. 759 *ff.*). A further lesson is that professional TTOs and a focus on licensing do not automatically preclude spin-offs. Patience and the nurturing of a certain culture is another important factor. Finally the Weizmann Institute shows that it pays to be not just a very good but a top academic environment with professional gateways to the outer world in order to attract top talent and industrial partners.

Source: Own research and *www.yedarnd.com/images/pics/UserImages/24h.pdf*; *www.weizmann.ac.il; www.ishitech.co.il/0904ar5.htm*.

Policy discussions of a "Swedish paradox" (high R&D input and low innovation output) (*e.g.* Bitard and Edquist, 2008; Edquist, 2010) question whether the knowledge created in universities is sufficiently "transformed" into innovations. Critics have argued that inputs into the academic system should yield more outputs in terms of patents, new firms and growth through entrepreneurship. In a discussion of the literature, however, Bourelos *et al*. (2012, pp. 753 *ff*.) do not support claims of an "ivory tower" mentality or of wrong incentives. On the contrary, they find evidence of complex, often soft forms of collaboration patterns, mainly on the individual or group level. As in many countries they find a positive correlation between publication records and transfer activities. This is confirmed by a survey of academics that finds positive attitudes towards collaboration and entrepreneurship.

Levels of academic patenting can be considered satisfactory if individual inventors who are academics are included in patent counts. Universities hold about 5% of total academic patents, with the other 95% held by individuals (without their university affiliation) (Bourelos *et al*., 2012, p. 755, referring to Lissoni *et al*., 2008). This is due to the so-called "professor's privilege" (*lärarundantaget*), which was introduced in 1949 in *Act 345 on the Right to Employees' Inventions* which states in paragraph 1 that academics at universities, technical colleges and other academic institutions shall not be considered as employees under the Act. While other Nordic countries have removed this exemption – Denmark in 2000, Norway in 2003 and Finland in 2007 – it is still in place in Sweden. Sweden and Italy are the only European countries with considerable academic R&D activity that retain the academic exemption.

There are two main arguments in favour of the professor's privilege. The first concerns expertise and red tape and the second incentives for spin-offs and entrepreneurship. Both can adduce supporting evidence but face counter-arguments. The "expertise" argument concerns the researcher-inventor's intimate knowledge of the invention compared to (often less experienced) TTO staff and potentially burdensome regulations. This line of argument is supported to some extent by the high hopes and meagre success of universities in many countries in building up, defending and profiting from their intellectual property (IP). Therefore, it is argued, it is better to let experienced researchers take care of their inventions and either create a firm or collaborate directly with firms that will offer a down payment and royalties to the inventor, who may then accumulate some personal wealth. One counter-argument in support of institutionalised IP portfolios is that universities are financed through taxpayers' money and provide the infrastructure and staff and a secure position for researchers, so that revenues from the invention should not belong to the individual inventor alone. Another argument is that universities need to know about their IP potential (and portfolio) in order to build a coherent transfer and commercialisation policy; however, an obligation placed on all staff to disclose inventions and ensuing deals would in part overcome this problem. The main counter-argument to the expertise argument seems to be that a long-term, highly professionalised transfer and commercialisation policy can succeed and contribute both to revenue streams to the university and to industrial development close to the campus. The example of the Weizmann Institute in Israel, a research institute with graduate students, offers an example (see Box 3.9) and provides potential lessons for smaller countries.

The second argument is that professional TTO structures prevent the creation of spin-offs, as there are clear incentives for TTO managers to license out IP to existing firms and receive quick and relatively safe returns. Spin-offs bring more long-term profit, as more patents appear to be actually used, the new firms may grow quickly, and will

probably be located close to the university, with the possibility of constant interaction with academics. Finally successful entrepreneurs often donate generously to their former universities. In a study of six North American universities (Kenney and Patton, 2011), one Canadian university still using a kind of professor's privilege had a much higher rate of academic spin-offs than the comparable but larger, richer and more research-intensive US universities included in the study. Arguments against the privilege include the relatively low number of direct academic spin-offs and strong incentives for academic researchers to enter "cheap" personal IP deals with industry. Moreover, in the last 20 years the number of academic spin-offs in the United States has increased nearly tenfold annually under the Bayh-Dole regime (Åstebro *et al*., 2012, p. 663, note 1). Åstebro *et al*. further argue that policy and universities should put more emphasis on spin-offs of graduates than on encouraging their staff to create firms. They show – with Halmstad, Chalmers and US universities as examples – that many graduates create their own firms within a few years after leaving university. They claim that such spin-offs are often of high quality in terms of technology, growth and profit. Therefore, universities should train students to become entrepreneurs and worry less about the ideal incentive structures for professors.

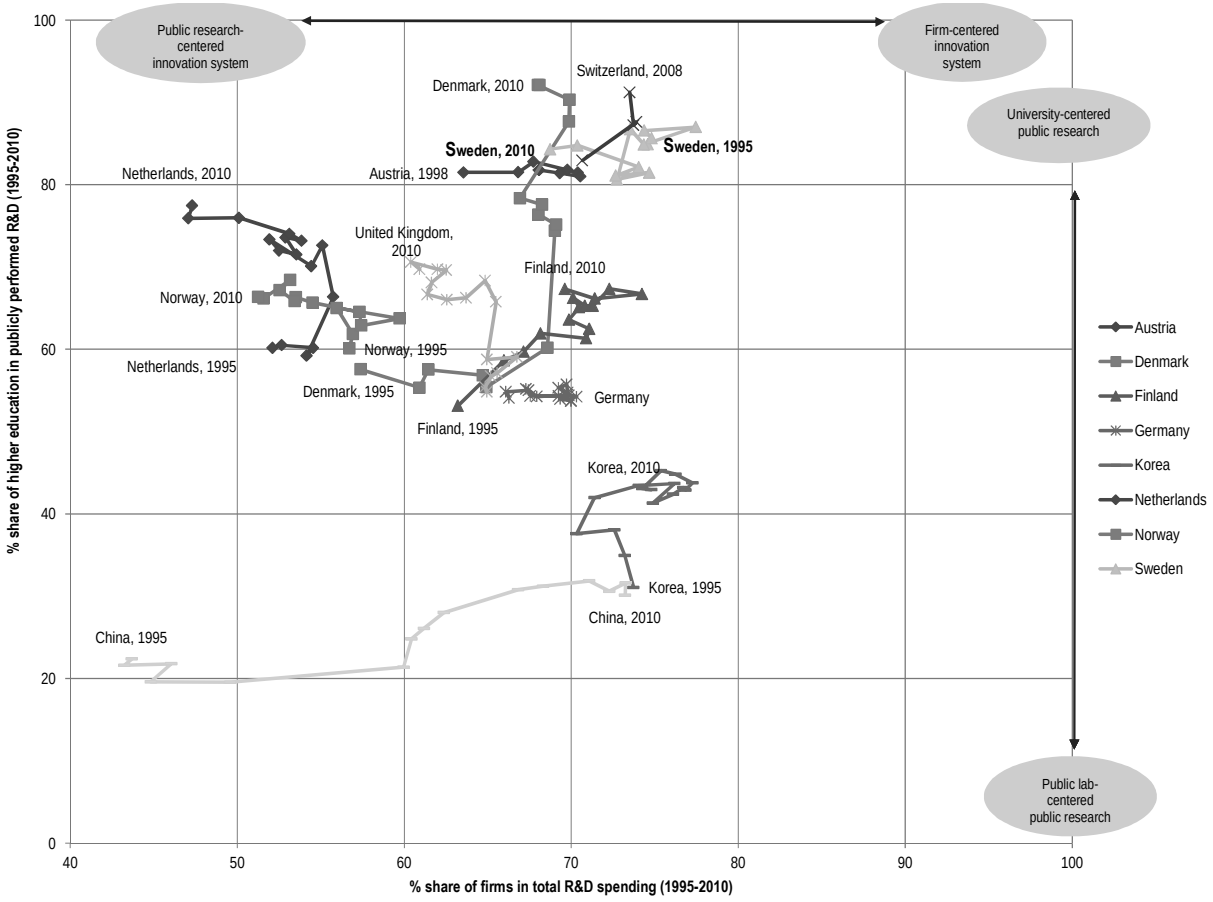
All in all, there are arguments for both forms of IP ownership. The issue has long been discussed in Sweden, but in contrast to most European countries, the professor's privilege has not been abolished. The issue should be considered again to see how to improve commercialisation arrangements, including some sort of institutional solution. At the very least, it would seem prudent to have academics report their IP holdings to their universities. The difficulty with full institutional solutions is the need for a long period of time to build portfolios and for highly professional staff. If this cannot be guaranteed it may be better to retain the professor's privilege.

3.3. Public research institutes

Across OECD countries, non-industrial research performance varies widely. Large countries such as Russia, but also to a certain extent the United States, rely on a large public research institute (PRI) sector, as do many smaller countries, such as the Czech Republic, Hungary or Slovenia. France, and to a lesser extent Italy and Spain, have a strong PRI sector which is closely linked to university research. A number of countries comparable to Sweden, such as Austria, Denmark and Switzerland, perform pre-competitive research mostly in the public university system. Finland and Korea have a more balanced distribution. Over time there has been a shift towards university-based research across the OECD (Figure 3.13). In Denmark recent university mergers have integrated a number of PRIs into a smaller number of large universities. Many industrialised countries in Europe have a strong industry-oriented PRI sector: Finland with VTT, the Netherlands with TNO or Germany with Fraunhofer. Switzerland does not have such applied research centres.

In Sweden most precompetitive and public research takes place in universities. Traditionally there has been a small PRI sector that accounts for just 3-5% of GERD (for the lower figure, see RISE, 2011, p. 6), in contrast to an EU average of 12%. In recent years, the PRI sector has grown; it is seen as an instrument of innovation policy for linking actors and serving industry as well as public needs. There are two main types of PRIs in Sweden; a third type, which focuses on scientific research (the Max Planck or the CNRS model), is covered in Sweden by the universities.

Figure 3.13. Proportion of R&D expenditures in firms, higher education and public research institutes in selected countries, 2010



Source: OECD Main Science and Technology Indicators, 2012/1.

First, there are PRIs which are more or less government agencies but have permission to charge for services performed. These include the Swedish Defence Research Agency (FOI) and VTI, which focuses on construction and analysis of the transport system. These agencies' main customers are the Defence and Transport ministries, respectively, and are covered here only briefly. Some of them are the legacy of a sectoral focus and/or follow the long-term trajectories of public-private technological developments, as in the defence sector.

The second type of PRI undertakes industrial research. Their main mission is to provide R&D services for the Swedish business sector. Private-sector businesses buy R&D services from the PRIs, while the state funds their facilities and skills development. The PRIs' work is largely demand-driven and acts as an interface between academic research and product development in the business sector. Their existence dates from the pre-war period, when they were run as purely industrial initiatives in sectors such as pulp and paper, metals, or power and fuels. An interesting outcome of this period was the use of the Royal Swedish Academy of Engineering Sciences (IVA) as a kind of holding structure which received and distributed public funding. On the public side the research councils did not run institutes. From the 1940s more than 20 industrial research institutes were created and received public support through funding and collaboration with sector

agencies (Kaiserfeld, 2010, pp. 42 *ff.*; Arnold *et al*., 2007, pp. 12 *ff.*). The aim was to boost applied research in and for different industrial fields. The sector grew in the 1960s but in the 1970s and 1980s basic public financing shrank sharply. There was a moratorium on new institutes with the government decision to focus on universities as providers of public knowledge. A parliamentary decision in 1979 stated that "the universities shall undertake a significant proportion of sector-related research, viz. research that aims to support or develop state agencies' activities". Universities were to function as "research institutes for the whole of society" (quoted in Arnold *et al*., 2007, p. 15). This went along with a strong budget increase for universities, mainly in the 1990s; PRI core funding was halved in the early 2000s (Arnold *et al*., 2007, p. 17).

The PRIs with a focus on industrial research have been consolidated into an umbrella holding, RISE (Research Institutes of Sweden) in order to improve strategic orientation, pool resources and exploit complementarities. The 22 RISE institutes have an annual budget of around SEK 2.5 billion (RISE, 2012, p. 41), an increase of 25% over the last four to five years. More than 20% of the budget appears to come from international sources, including industry sources and the EU Framework Programme. RISE is the fifth largest Swedish FP7 recipient (RISE, 2011, pp. 6 and 31). In general more than 50% of turnover comes from industry projects, 19% comes from government funding in the form of strategic competence funds (RISE, 2011, p. 30) and another 18% from various public sources. RISE has a large number of SME clients and SME-targeted activities and a large number of testing facilities for enterprises of all sizes.

RISE continues to be developed as one of the priorities of the 2008 Research and Innovation Bill (Swedish Government, 2008, pp. 128 *ff.*). A main development goal is to strengthen the institutes as interfaces between academia and industry and as providers of useful research for firms. An additional EUR 20 million was provided in the research bill for 2009-12 to achieve this goal and to strengthen basic budgets and strategic options. An effective board structure was also created.

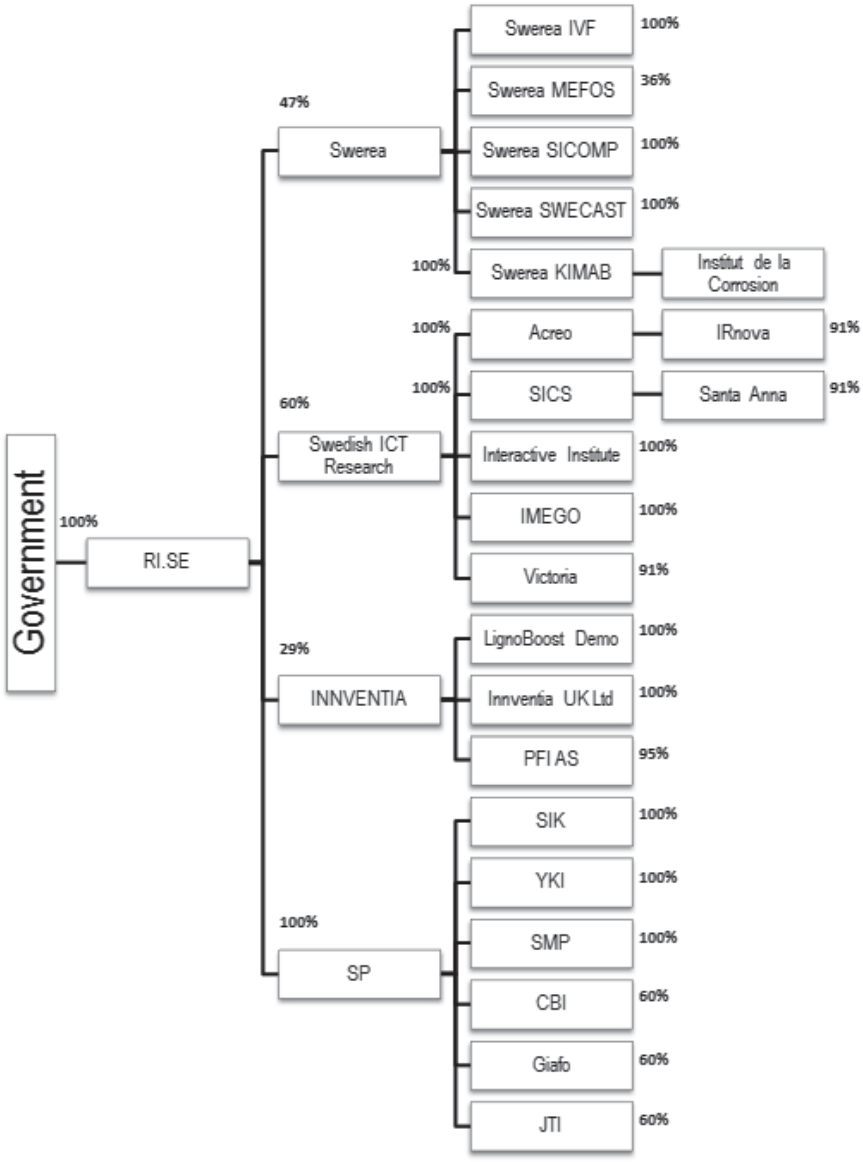
RISE has four main sub-structures with a number of individual institutes clustered around broad topics, such as ICT. The institutes are all organised as non-profit limited liability companies and have different business approaches depending on the sectors they serve. The models range from testing contracts to research consortia involving business enterprises and universities. Taken together, the institutes employ more than 2 200 people; more than a third have PhDs and 65 are also professors at universities.

Figure 3.14 shows the structure of the RISE institutes. The four clusters of institutes, each of which is located in five to ten different places all over Sweden, are as follows:

- The largest is SP, the Swedish Technical Research Institute, with six institutes for various forms of technical research with a strong focus on testing and measurement in fields such as building, life sciences, energy, environment or transport. It employs more than 1 000 people, and accounts for half of RISE staff. SP is fully owned by the government.
- Swedish ICT has six institutes and about 420 staff for microelectronics, computer sciences and informatics for specific industrial sectors, some with strong links to technical universities. The government has a 60% share in Swedish ICT.
- Swerea has six institutes in fields such as production technology, eco-design, process technology and materials and employs 570 staff. The Swedish government owns less than 50% of Swerea.

- Innventia has three institutes whose mission is to perform R&D in forest-based biomaterials, including pulp and paper, printing and packaging. With nearly 340 staff this is the smallest of the four RISE sectors and the government has only a 29% share.

Figure 3.14 Structure of the RISE institutes



Source: Adapted from RISE (2012). The numbers indicate direct and indirect public ownership shares.

Overall RISE seems to be on a satisfactory path, although it has a broad range of institute set-ups, sizes, business models and success. The two historically strong forms of activities, applied research for product and process development and testing, training and prototyping (Arnold *et al*., 2007, p. 55), continue to dominate. RISE sees a number of challenges ahead:[13] to increase synergies between institutes, to build a stronger customer orientation, to form alliances with universities with work shared along the basic-applied research borderline, to brand RISE as a sector, to increase internationalisation with more EU FP participation, to develop a stable financial business model, to seek more impact, and to provide incentives for collaboration.

Government support for research institutes has been increasing in recent years. Specific support mechanisms include VINNOVA's Institute Excellence Programme for RISE institutes and public-sector agencies such as FOI (see Chapter 4). It currently has eight centres which run for six years and aim to strengthen research consortia involving the institutes, academia and various firms. At the same time, like the competence centres and excellence centres for universities, these centres support new planning and management tools in the institutes funded, apparently with some success (Märtensson *et al*., 2009; Stenius *et al*., 2008). However, these initial findings also highlight the need for stronger strategic orientation.

A number of successful institutes work in "triangles" with the universities and the private sector. The development of links between universities and RISE is seen as an opportunity for collaboration. The EIT KICs appear to be a valuable example in the field of ICT, as they build on long-standing collaboration between Ericsson, RISE institutes and KTH. A number of RISE institutes play useful roles in cluster settings and production networks of multinational enterprises (MNEs). In the case of the latter, they tend to work more with second-tier suppliers than directly with core MNE research facilities. RISE also benefits from government policy initiatives at the regional level where RISE institutes have successfully participated in VINNVÄXT consortia (see Chapter 4).

There is clearly a role for RISE in the Swedish innovation system and institutes and universities should not be viewed as substitutes (Arnold *et al*., 2007, p. 81). Given that the PRI sector is still rather small by international standards, there is probably room for a step-wise expansion of RISE and its networks. However, two important caveats should be borne in mind. First, knowledge about Swedish firms, particularly SMEs but also larger firms that are not MNEs (referred to as the *Mittelstand* in German-speaking countries), and about their innovation and R&D needs could be improved. It has proved difficult for this review to obtain information about such firms, their needs and strategies, and their positions in value chains. Industrial research institutes like the RISE centres have only one reason to exist, and that is their usefulness to customers. It would therefore be important to know more about these customers and then to strengthen the institutes with high (potential) demand for their services.

Second, universities and PRIs often form alliances; this is a good thing, as the two types of organisation are complementary. However, the immediate need to strengthen the research capacities of PRIs engaged in such alliances is less obvious than the need for them to respond to SMEs with innovation competences and help them reduce their innovation-related risks. This need for a clear focus is underlined by the currently low flows of industry money to public research institutes (see Figure 3.1).

3.4. Non-governmental intermediary organisations

As in many other OECD countries, Sweden has a rich landscape of non-governmental organisations that support innovation and R&D activities in one way or another. Some represent the interests of specific groups, such as industry associations, trade unions and professions, and seek to influence public policy on innovation. Others, including private foundations and medical charities, provide funding for R&D. There is also a widely distributed network of incubators, science parks and other support organisations for entrepreneurship and innovation. Given the large number of intermediary organisations in Sweden, only a few are briefly covered here.

Industry associations

The Confederation of Swedish Industries (*Svenskt Näringsliv*) is Sweden's largest business federation. It represents 49 member organisations and 60 000 member companies employing over 1.6 million people. Member organisations are a mix of industry associations and employer trade associations.[14] The Confederation seeks to influence politicians and other decisions makers to achieve a better business climate and has a keen interest in seeing improvements to Sweden's education and research system, including greater attention to entrepreneurship education.

The Association of Swedish Engineering Industries (*Teknikföretagen*) is a prominent example of an employer trade association with a strong emphasis on technological innovation. It has 3 500 member companies with 300 000 employees. Its stated mission is to know the needs of its members and to represent these in relevant policy dialogue. It works on a range of issues, notably improving the efficiency of Swedish R&D, supporting co-operation between education institutes and industry, and inspiring young people to pursue engineering careers. For example, in collaboration with several partner organisations, including VINNOVA, the Association developed a research agenda, *Swedish Production Research 2020* (Teknikföretagen, 2009), which identified the need for more co-ordinated research in the production sector. This project served to bring together representatives from industry, academia, research institutes and research funding agencies to identify and implement strategic projects in both established and new areas of production. More recently, the Association formulated a policy agenda, the Industrial Policy Programme (Teknikföretagen, 2011), to strengthen innovation through a range of measures, including labour market reforms and changes to the education system.

Almega represents the services sector. It has 10 000 member companies employing some 500 000 people. As with similar organisations in other sectors, Almega supports its members in their relations with trade unions and seeks to shape public policy agendas, particularly on issues of skills development and labour market regulations. It also has a strong interest in promoting the notion of services innovation and in making better known the close relationship between Swedish manufacturing and services. For example, it published a report (Edquist, 2011) highlighting a structural shift in the Swedish economy since the mid-1990s whereby investment in intangible assets has become increasingly important for productivity growth. While productivity growth in Swedish manufacturing has been particularly impressive, the report argues that intangible investment in knowledge-intensive services has played an important role in this growth. The report concludes that it is not manufacturing alone but the interaction between manufacturing and services that has been crucial for the Swedish economy's strong productivity performance since 1995. Almega has to make this point often to ensure that

policy debates are not framed in terms of support for manufacturing *or* services but are instead sensitive to the interdependencies between them. More recently, as part of its input to the government's 2012 Research and Innovation Bill, Almega published a report (*Tjänsteinnovationer – för ökad konkurrenskraft*) highlighting the importance of innovation in services and setting out a number of priorities for research in the field.

Professional associations

Founded in 1739, the Royal Swedish Academy of Sciences (*KVA – Kungliga Vetenskaps Akademien*) is an independent organisation whose overall objective is to promote the sciences and strengthen their influence in society. The Academy is perhaps best known internationally for its awards for prominent contributions to research: it grants the Nobel Prizes in Physics and Chemistry and the Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel (Box 3.10). At a national (and increasingly European and global level), the Academy seeks to act as a voice for science and influence research policy priorities. For example, in the run-up to the new 2012 Research and Innovation Policy Bill, the Academy called on the government to provide quality assurance for government research appropriations; ensure long-term co-ordination of Swedish research policy; work to strengthen basic research in Europe; foster academic mobility and the long-term supply of knowledge; invest in individual creative researchers; improve infrastructure; and rehabilitate know-how in mathematics, natural sciences and technology (KVA, 2011). More recently, the Academy has published a comparative study chronicling Sweden's decline in fostering breakthrough research (Öquist and Benner, 2012). The Academy also works to stimulate interest in mathematics and the natural sciences in schools and supports young researchers.

Box 3.10. Nobel prizes

The Nobel Prize is the world-renowned award for physics, chemistry, physiology or medicine, literature and peace which is given to individuals for their intellectual achievements. It has its source in the last will and testament of the Swedish chemist and industrialist Alfred Nobel (1833-96). Since 1969 the Prize in Economic Sciences in Memory of Alfred Nobel is awarded by the Royal Swedish Academy of Sciences on the same principles as those applied to the five Nobel Prizes that have been awarded since 1901. Swedish institutes generally play a prominent role in the selection process and award ceremony. The institute responsible for the selection of the Nobel laureates in physics and chemistry is the approximately 600 member strong Royal Swedish Academy of Sciences, for physiology or medicine it is the Karolinska Institutet, and for literature it is the 18 member Swedish Academy. The Nobel Peace Prize is in the responsibility of the Norwegian Nobel Committee. Between 1901 and 2011, the Nobel Prizes and the Prize in Economic Sciences were awarded 549 times to 853 Nobel laureates (23 organisations and 830 laureates, only 43 of whom have been women). The countries with the most Nobel Prizes are the United States, the United Kingdom, Germany, France, Sweden and Switzerland. The Nobel Prize helps to put Sweden firmly on the global science map.

The Royal Swedish Academy of Engineering Sciences (*IVA – Kungliga Ingenjörs Vetenskaps Akademien*) was founded in 1919 and is the world's oldest academy of engineering sciences. It describes itself as a "bridge builder" to promote cross-fertilisation among industry, academia, public administration and various interest groups. It does this through a range of activities, including conferences and research projects. It is built around an expert network of close to 1 000 distinguished engineers and economists from business and industry, education and public administration. Its reports are highly regarded and often take a long-term perspective. IVA has been responsible for leading several technology foresight studies over the last decade, often in partnership with other interested actors. In recent years, it has led the *Innovation for Growth*

dialogue, which provided inputs to the government's Innovation Strategy process and culminated in the publication of *Innovation Plan Sweden* (IVA, 2011), and has initiated a large project on a future research agenda for Sweden (Box 3.11).

Box 3.11. IVA's Agenda for Research project (2010-12)

In 2010, IVA initiated a three-year project, *Agenda for Research*, to discuss the long-term strengthening of research and innovation in Sweden. The project provides a forum for discussion of research policy issues between elected officials in the government and in Parliament, research funders, organisations that conduct research (universities and public research institutes) and users of research results (trade and industry, the public sector and non-governmental organisations). The aim is to help move research and innovation issues higher up on the political agenda. Discussion is based on existing reports and on studies commissioned when target groups saw a need for further analysis. These include *University of the Future*, *Research and Innovation Foresight*, *Sweden and European Research*, and *Prioritising Research and Innovation*. Through this process, the project has generated inputs to the government's 2012 Research and Innovation Policy Bill. Roundtable discussions, hearings and seminars are also important components of the project.

Source: IVA website, *www.iva.se*.

Private foundations funding research

Taken together, private non-profit organisations contribute around EUR 230 million to Swedish research.[15] According to one source (European Foundation Centre, 2009, pp. 95 *ff.*), around 2 000 foundations support research in Sweden in some way. This study claims that EUR 400 million in R&D funding is provided by private foundations, although the figure includes the wage-owner funds' foundations, which are best described as semi-public (see Chapter 4). Even if these last funds are discounted, the amount is very high in a comparative European context and puts Sweden at the forefront in philanthropic funding of research. The study suggests that the number of foundations is more or less the same as in the much bigger United Kingdom.

Prominent among Swedish foundations are the various Wallenberg Foundations created by members of the powerful industry and banking dynasty. The largest and most important is the Knut and Alice Wallenberg Foundation (KAW), which dates from 1917. KAW can currently spend nearly SEK 1 billion a year, mainly on larger research projects and major infrastructure investments, complemented by scholarships and fellowships and strategic projects. KAW is therefore a major actor in the Swedish research funding landscape. The larger projects and infrastructure funding are evaluated externally and are preceded by joint planning activities with the universities. Major funding initiatives (though not in the form of thematic programmes) include genomics, proteomics, neurosciences, ICT and bioengineering. In contrast to most other Swedish research funders (see Chapter 4), KAW puts no emphasis on co-financing activities with other funding sources (Forskning.se, 2010, p. 23). Besides KAW, half a dozen other Wallenberg Foundations support different kinds of activities and projects in research and higher education.

The Swedish Cancer Society can distribute nearly EUR 40 million a year for oncological research and finances a large number of projects each year. Other notable foundations focus on clinical research on childhood cancers or heart-lung diseases. These medical foundations are organised as fundraisers (Forskning.se, 2010, pp. 20-22). Besides these larger actors, many other smaller and mid-sized private foundations, such as the Söderberg Foundation or Kempe Foundation, provide funding for different kinds of research.

Incubation and entrepreneurship support

Swedish Incubators & Science Parks (SISP)[16] is a member-based, non-profit association of Sweden's incubators and science parks. SISP was founded in 2005 through a merger of two voluntary organisations, SwedSpin (incubators) and Swede Park (science parks). SISP has 65 member organisations which seek to act as nodes in regional Swedish innovation systems. Its members include over 5 000 companies employing more than 72 000 people. Swedish incubators provide dedicated business support services to start-up and early-stage firms. They evaluate approximately 4 000 business ideas a year and have almost 800 companies in their environments employing around 3 500 people. Some 150 of these firms annually attract venture capital funding. Swedish science parks seek to stimulate the flow of technology and knowledge among university research departments, technology development institutes and firms. They are connected to more than 4 000 companies, most of which are SMEs. However, there is a growing trend to connect to large firms which seek access to "open innovation" arenas that the science parks can provide.

The Swedish Entrepreneurship Forum describes itself as a network organisation for generating and transferring policy-relevant research in the field of entrepreneurship and small enterprise development. It aims to serve as a bridge between the small business research community and the various actors concerned with development of new and small enterprises. It has recently published reports on topics such as venture capital, the role of entrepreneurship and innovation in economic growth, and barriers to the adoption of ICTs in SMEs.

The Forum for Social Innovation Sweden is a meeting place for academia, industry, government, civic society and non-profit organisations to come together to create an understanding of social innovation and social entrepreneurship and how it can contribute to Swedish and global development. The Forum is a collaborative effort supported by some 20 stakeholder groups, including national funding agencies, local authorities, universities and large firms. It focuses on areas such as sustainable urban development, rural development, leadership, social financing and corporate social responsibility.The Forum develops joint projects, partnerships and new products and services. It supports, scales up and disseminates social innovations and supports social entrepreneurs working in the field.

3.5. Human resources for science, technology and innovation

Human resources are a main pillar of knowledge-based economies and as such are a major concern of innovation policy. Box 3.12 highlights the many ways in which human resources spur innovation and points to the importance of a broad set of knowledge and skills beyond science and engineering. These broad human resources can be built and accumulated through education and training, work-place experience, and international migration, for example. Existing human resources, particularly women, can also often be better utilised in research and innovation. This section discusses Sweden's stock of human capital and the roles of education, migration and gender equality in renewing and making use of it.

Box 3.12. How do human resources spur innovation?

Generating new knowledge

Skilled people generate knowledge that can be used to create and introduce an innovation. For instance, Carlino and Hunt (2009) found that the presence of an educated workforce is the decisive factor in the inventive output of American cities; a 10% increase in the share of the workforce with at least a college degree raises (quality-adjusted) patenting per capita by about 10%. Data on Spanish regions also found a positive relationship between levels of human capital and the number of patent applications (Gumbau-Albert and Maudos, 2009). In an alternative approach, using "new work" (*i.e.* new statistical occupational categories) as an indicator of innovation, Lin (2009) found that locations with a high share of college graduates have more jobs requiring new combinations of activities or techniques. Such jobs appeared in the labour market along with the application of new technologies and knowledge.

Adopting and adapting existing ideas

For many countries, incremental innovations involving modifications and improvements to existing products, processes and systems can represent the bulk of innovation activity and can have great significance for productivity and the quality of goods or services. Higher skill levels raise economies' absorptive capacities and ability to perform incremental innovation by enabling people to understand how things work and how ideas or technologies can be improved or applied to other areas. Importantly, skills for adoption and adaptation are beneficial across the wider workforce and population, not just in R&D teams. Toner (2007) argued that the production workforce plays a particularly strong role in incremental innovation when management encourages and acts on suggestions for improvement. Skills and absorptive capacity are also required in functions and activities such as marketing. At the same time, more skilled users and consumers of products and services can contribute to the adaptation of existing offerings by providing the supplier with ideas for improvement.

Enabling innovation through capacity to learn

Skilled people have a greater ability to learn new skills, to adapt to changing circumstances and to do things differently. In the workplace, educated workers have a better set of tools and a more solid base for further "learning", thereby enhancing their ability to contribute to innovation. Leiponen (2000) found that, in contrast to non-innovating firms, innovators' profitability was significantly influenced by the amount of higher education, higher technical skills and research skills possessed by employees.

Complementing other inputs to innovation

By interacting with other inputs to the innovation process, such as capital investment, people with better skills can spur innovation. For instance, Australian research has shown that human capital complements investment in ICTs, with the uptake and productive use of ICTs significantly influenced by management and employee skills (Gretton *et al*., 2004). A Canadian study found that a firm's human resource strategy, as well as its innovation strategy and business practices, influenced the extent to which it adopted new advanced technologies (Baldwin *et al*., 2004). Equally, because of its complementary nature, a firm's lack of human capital is likely to exacerbate other constraints on innovation. Mohnen and Röller (2001) concluded that measures aimed at removing barriers to innovation may be more effective if also explicitly directed at increasing levels of internal human capital.

Generating spillovers

Human capital can contribute indirectly to innovation through the "spillovers" generated by skilled people. For instance, not only do skilled workers diffuse their knowledge throughout their workplace and the wider environment, they may also, through their interactions and their explicit or implicit actions as role models, spur faster human capital accumulation by other workers. Both of these factors can spur innovation through the spread of ideas and the upgrading of competencies. It has also been suggested that entrepreneurs "spill" knowledge by commercialising ideas that would otherwise not be pursued within the organisational structure of an existing firm (Acs *et al*., 2009).

…/…

Box 3.12. How do human resources spur innovation? *(continued)*

Contributing to social capital

Higher levels of human capital enhance social capital, and social capital can support innovation in several ways, predominantly through its effect on trust, shared norms and networking, which improve the efficiency and exchange of knowledge. Some studies suggest that improved levels of trust can promote venture capital financing of risky projects, owing to factors such as reduced monitoring costs (Akçomak and ter Weel, 2009). Closer relationships between actors can lead to the exchange of proprietary information and underpin more formal ties (Powell and Grodal, 2005), while social networks may also enable firms to work through problems and get feedback more easily, thereby increasing learning and the discovery of new combinations (Uzzi, 1997). Firms with higher levels of social capital are more likely to engage specialist knowledge providers, such as the public science base, to complement their internal innovation activities (Tether and Tajar, 2008). Social capital is also a feature of "invisible colleges" that bind researchers across geographic space in pursuit of common research interests.

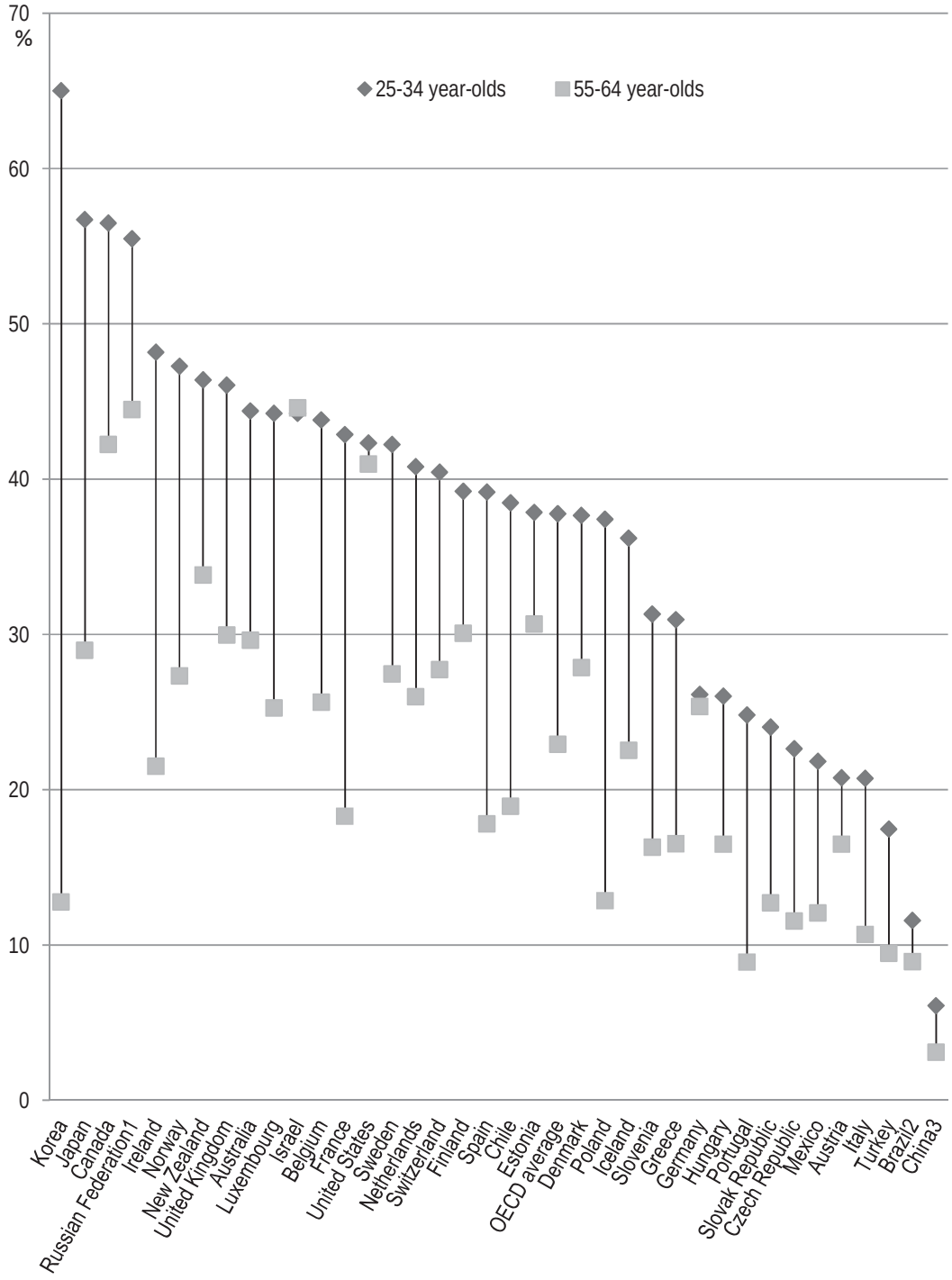
Source: OECD (2011), *Skills for Innovation and Research*, OECD, Paris.

3.5.1. Education and training

Educational attainment is a commonly used proxy for assessing a country's overall performance with respect to human resources and Sweden's position is strong in this respect. In Sweden 34% of adults have a tertiary qualification (2010) compared to an average of 31% across OECD countries. Figure 3.15 shows the share of different population age-groups with tertiary education. For both older and younger cohorts, Sweden is above the OECD averages. Moreover, in 2010, 87% of Swedes between 25 and 64 years of age had attained upper secondary education, significantly above the OECD average of 74% (OECD, 2012). While now more than a decade old, the International Adult Literacy Survey (OECD and Statistics Canada, 2000) found that Sweden had the highest level of adult literacy among the 20 countries surveyed and the narrowest distribution of literacy skills.

One way of assessing the recent output and uptake of high-level skills is to consider the number of graduates in science-related fields (science and engineering, manufacturing and construction) per 100 000 25-34 year-olds in employment (Figure 3.16). This indicator does not show the number of graduates actually employed in scientific fields or deploying their scientific skills at work, only their presence in the workforce. The indicator ranges from below 1 000 in Hungary to above 3 500 in Korea. At 1 596, Sweden ranks somewhat below the OECD average of 1 829. However, other indicators suggest comparatively stronger performance in science-related human resources: in 2008, of every thousand persons in employment in Sweden 11 were researchers, the fourth highest number in the OECD area. In the same year, a quarter of all new degrees were awarded in science and engineering fields, above the OECD average.

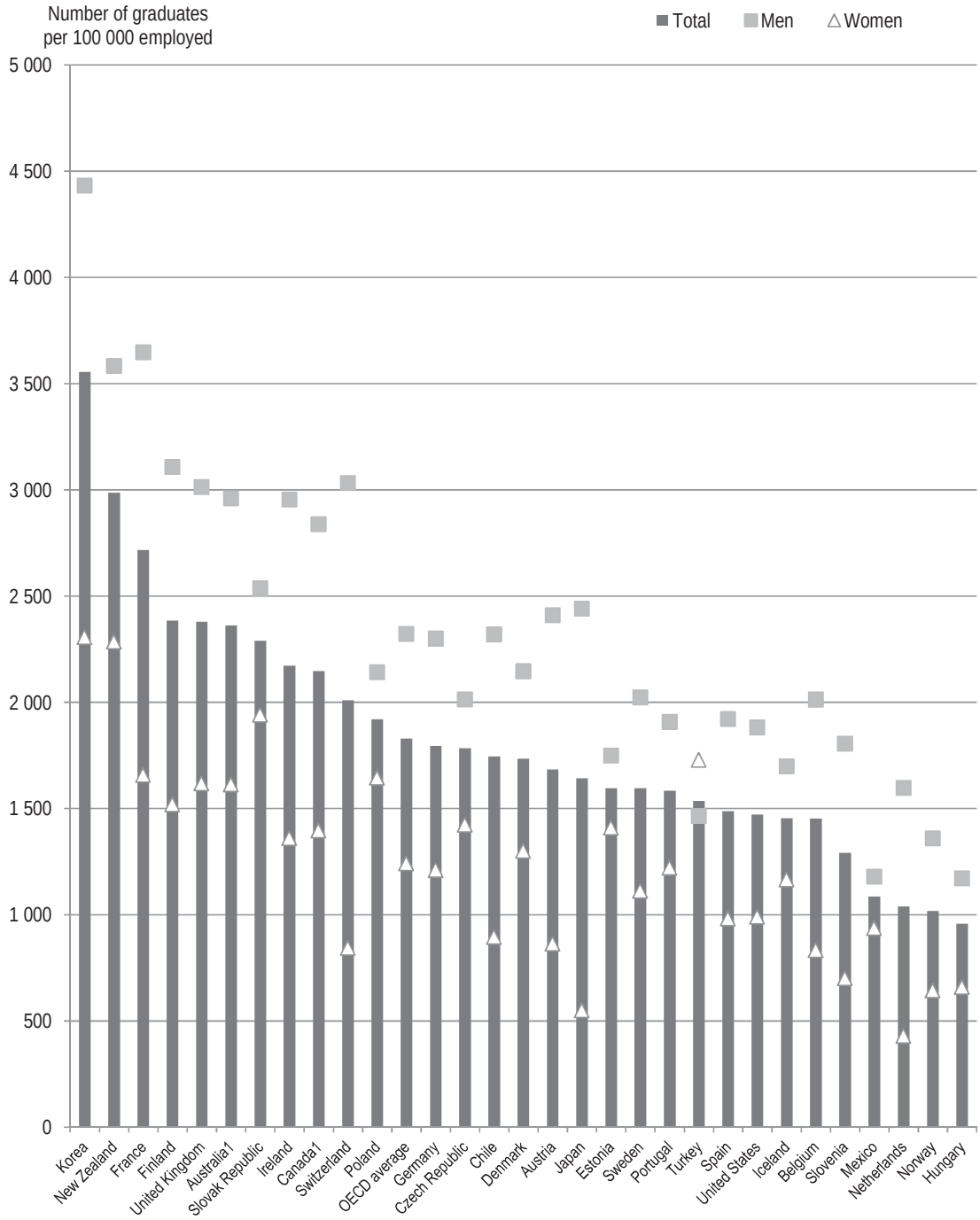
Figure 3.15. Percentage of the population with tertiary education, by age group (2010)



1. Year of reference 2002.
2. Year of reference 2009.
3. Year of reference 2000.

Source: OECD, *Education at a Glance 2012*.

Figure 3.16. Tertiary graduates in science-related fields among 25-34 year-olds in employment, by gender, 2009



Note: Science-related fields include life sciences; physical sciences, mathematics and statistics, computing; engineering and engineering trades, manufacturing and processing, architecture and building.

1. Year of reference 2008 for the number of graduates.

Countries are ranked in descending order of the percentage of tertiary science-related graduates in tertiary-type A programmes per 100 000 employed 25-34 year-olds.

Source: OECD, *Education at a Glance 2011*.

In terms of production of new graduates, 36.3% of the Swedish population aged 20-29 were in tertiary education in 2008, above the EU27 average of 29.8% (Table 3.14). Tertiary students in science, mathematics, computing, engineering, manufacturing and construction account for 24.7% of students, comparable to the EU27 average of 24.3%. However, when broken down, the percentage of tertiary students in science, mathematics and computing is 8.9%, below the EU27 average of 10.3%, but in engineering, manufacturing and construction it is 15.8%, slightly above the EU27 average of 14.1%. The average annual growth rate (AAGR) of tertiary students in all fields and in science and engineering (S&E) during 2003-08 is negative for Sweden with -0.3% AAGR for all fields and -2.3% AAGR for S&E; the EU27 averages are 4.2% and 3.3%, respectively.

Table 3.14. Students participating in tertiary education, total and selected field of study

Share of the population aged 20–29 and of all tertiary students, EU27 and selected countries, 2008

	All fields			S&E (1)			Science, mathematics and computing	Engineering, manufacturing and construction
	Total number in 1000s	As a % of population aged 20-29	AAGR 2003-2008	As a % of population aged 20-29	As a % of all tertiary students	AAGR 2003-2008	As a % of all tertiary students	As a % of all tertiary students
Austria	285	27.2	4.4	7.0	25.5	4.7	11.6	13.9
Denmark	231	37.2	2.8	6.7	18.0	0.9	8.2	9.8
Finland	310	49.0	1.3	17.6	35.9	0.0	10.9	24.9
France	2 165	28.5	-0.8	7.2	25.3	0.0	12.3	13.0
Germany	2 245	23.3	0.2	7.2	31.0	0.8	15.2	15.8
Italy	2 014	30.1	1.1	6.9	22.9	0.2	7.6	15.3
Netherlands	602	30.8	2.8	4.4	14.3	0.3	6.2	8.1
Norway	213	36.1	0.2	5.8	16.0	-1.9	8.5	7.5
Sweden	**407**	**36.3**	**-0.3**	**9.0**	**24.7**	**-2.3**	**8.9**	**15.8**
Switzerland	224	24.0	5.5	5.4	22.7	1.6	9.9	12.7
United Kingdom	2 329	28.7	0.4	6.1	21.1	0.3	12.9	8.2
EU-27	**19 040**	**29.8**	**4.2**	**7.3**	**24.3**	**3.3**	**10.3**	**14.1**

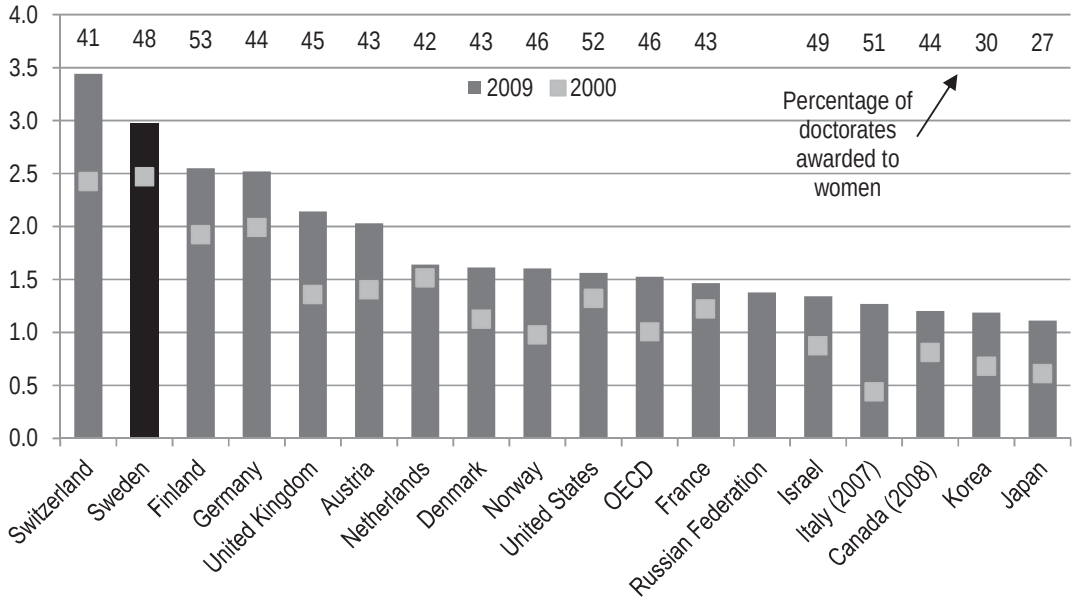
1. S&E = science, mathematics, computing + engineering, manufacturing and construction.

Sources: Eurostat (2011c), p. 61 and for AAGR p. 63.

Sweden has relatively high graduation rates at the doctoral level (Figure 3.17). Among comparator countries, Sweden had the highest and second-highest (behind Switzerland) rates for 2000 and 2009, respectively. Sweden's rate of doctorates increased over time from 2.5% in 2000 to 3% in 2009, an increase analogous to that of most other comparator countries. Switzerland and Italy and to a lesser extent the United Kingdom and Norway stand out as the countries with the largest gains. Sweden also compares very favourably in terms of gender equality (defined as the absolute difference from 50%), with female graduates accounting for 48% of total graduates, only marginally behind Israel and Italy.

Figure 3.17. Graduation rates at the doctoral level, 2000 and 2009

As a percentage of the population in the reference age cohort

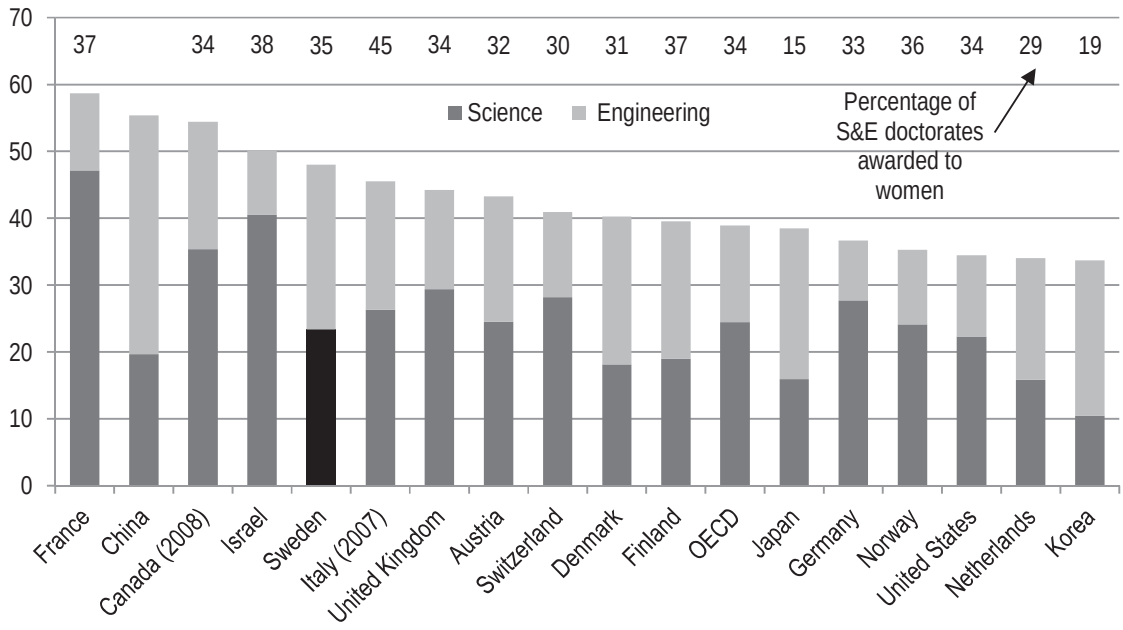


Source: OECD Science, Technology and Industry Scoreboard 2011, p. 68, based on OECD (2011), *Education at a Glance 2011: OECD Indicators* and (2009) *Education at a Glance 2009: OECD Indicators*, OECD, Paris.

The share of science and engineering doctoral graduates in Sweden in high, but lower than in countries such as France, China, Canada and Israel. In 2009, 48% of graduates at the doctoral level had completed either a science or engineering degree (Figure 3.18). The share of students graduating in engineering is particularly high, but in science (23.3%) it is below the OECD average of 24.4%. Across countries, women are less well represented in science and engineering doctorates; this is also true in Sweden, where women are awarded only 35% of S&E doctorates, compared to 48% across all subject areas. Italy and Israel, but also France and Finland, have a distribution that is closer to gender parity than Sweden.

Figure 3.18. Science and engineering graduates at the doctoral level, 2009

As a percentage of all new degrees awarded at the doctoral level

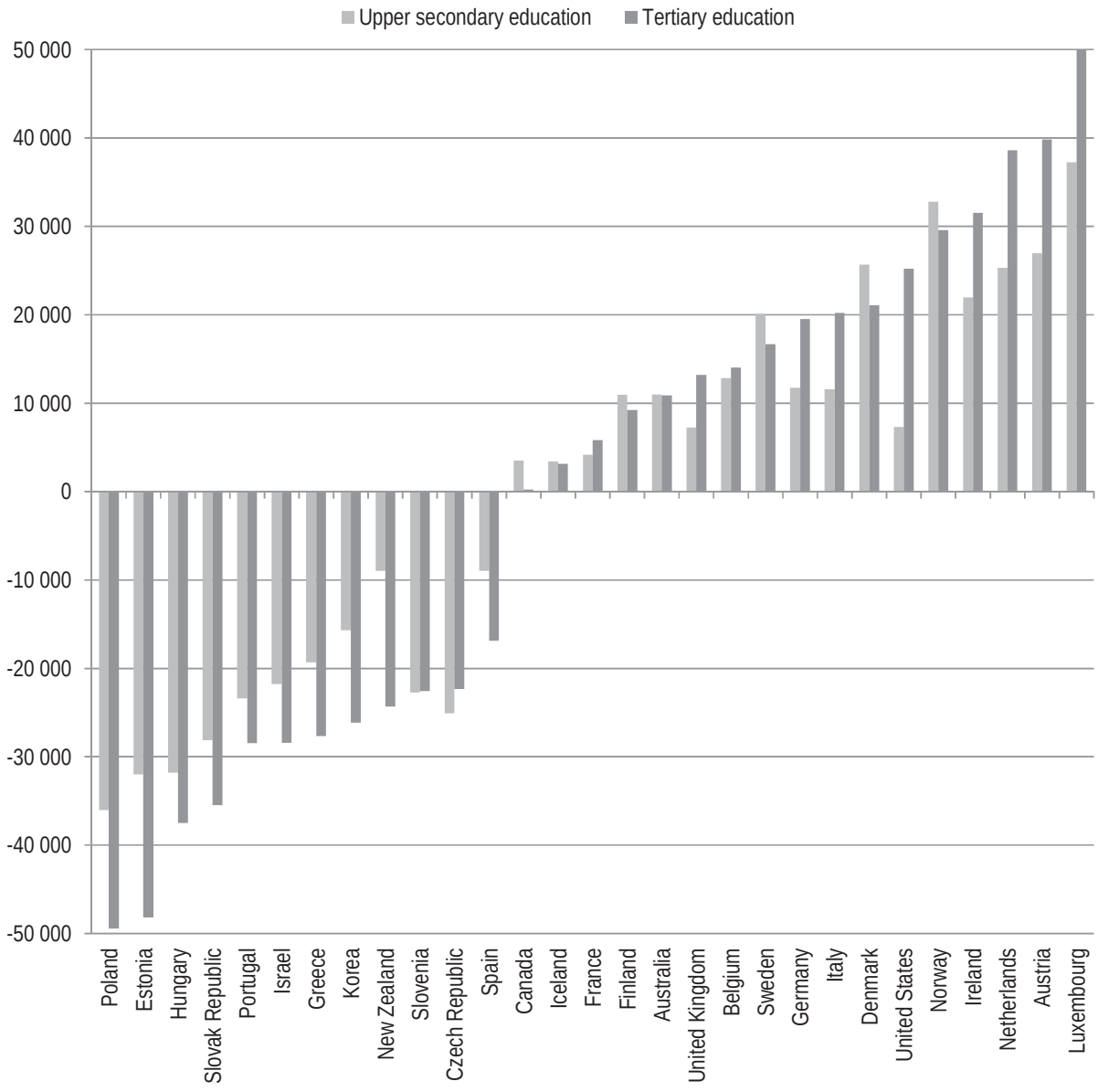


Source: *OECD Science, Technology and Industry Scoreboard 2011*, p. 69, based on OECD Education Database, September 2011 and OECD calculations based on national sources, May 2011.

Some employers indicated to the OECD review team that Swedish companies face a shortage of engineers. This claim was disputed by people working in education. No empirical evidence to determine whether the purported shortages are real or significant was available to the team. Nevertheless, there is an ongoing debate in Sweden regarding salaries for engineers. Some argue that large companies in particular need to make salaries more attractive to increase the supply of engineers. One way to consider this issue is to compare cost structures across countries. Figure 3.19 shows cross-country variations in the price of labour by educational attainment. For those with upper secondary and tertiary education, the height of the bars indicates the difference in average earnings from the OECD average for persons in the two categories of educational attainment (on average, across the OECD, annual labour costs for men and women with an upper secondary education are USD 46 000; for those with tertiary education they are USD 68 000). For Sweden, Figure 3.19 shows that the annual average cost of employing persons with upper secondary education is about USD 20 000 higher than the OECD average. The cost of employing persons with tertiary education is also higher than the OECD average, but by a smaller margin (some USD 17 000). Stated differently, from an OECD perspective, Swedish individuals with tertiary education (as well as those in Belgium, Denmark and Finland) are less expensive to employ than those with less education. A compressed wage structure and strong labour unions may help to explain these results. As these data are not occupation-specific, they cannot shed light directly on a possible scarcity of engineers. But they do indicate that remuneration of the better educated – possibly including engineers – might not be as attractive in Sweden as in some other countries. In the context of an increasingly internationally integrated labour market – in which the more skilled are also more mobile – this could affect the labour supply.

Figure 3.19. Deviation from the OECD mean in annual labour costs, by educational attainment

In equivalent USD for the 25-64 year-old population

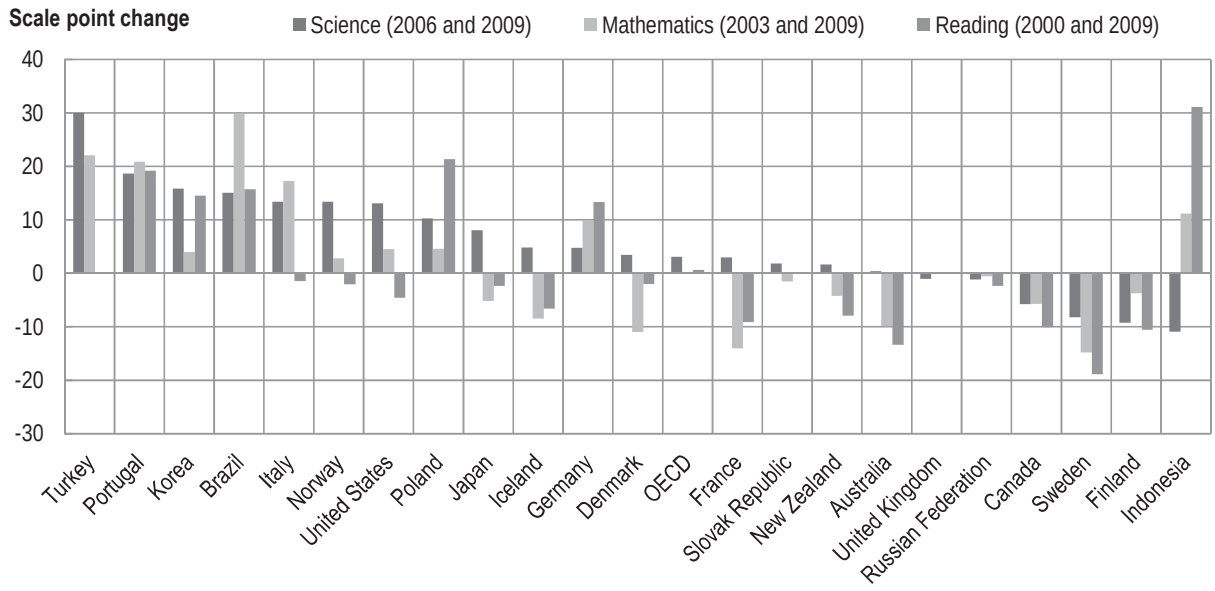


Countries are ranked in ascending order of the deviation from the OECD mean in annual labour costs of tertiary educated individuals.

Source: OECD, LSO Network special data collection on full time, full year earnings, Economic Working Group. Table A10.1. See Annex 3 for notes (*www.oecd.org/edu/eag2011*).

There are also some problematic developments in earlier stages of education in Sweden. Specifically, as measured in international surveys such as PIRLS, TIMMS and PISA, educational results in Swedish schools have been declining since the mid-1990s in all subjects.[17] Results have worsened most in upper secondary schools and in mathematics and science. Figure 3.20 shows evidence of strong performance declines in all three areas (science, mathematics and reading) in Sweden's PISA performance over the last decade or so.

Figure 3.20. Changes in PISA performance, 2009.



Source: OECD (2010), *PISA 2009 at a Glance*, OECD, Paris.

Sweden invests heavily in education. It allocated 7.3% of GDP to education in 2010 (including R&D in HEIs), compared to the OECD average of 5.8%, a share that has been increasing since the mid-1990s. In 2010, Sweden spent USD 11 400 per student from primary to tertiary education, more than USD 2 000 more per student than the OECD average (OECD, 2012). Financing of education is therefore unlikely to be an important factor in explaining declining student performance. There is, however, evidence that for some years the teaching profession has become a less attractive vocation, with high-performing students opting for studies other than teaching (Swedish Fiscal Policy Council, 2011). This has also led to shifts in the age distribution of teachers in secondary schools: in 2010, less than 7% of teachers were younger than 30 and around 41% were older than 50. This is a serious challenge for Sweden, and several reforms are attempting to make the teaching profession more attractive (Box 3.13).

Box 3.13. Making teaching more attractive

Between 2000 and 2010, teachers' salaries increased by an average of 22% across all OECD countries, while in Sweden, they increased by only 8%. Except for starting salaries, there is a wide gap between teachers' salaries in Sweden and the OECD average. The starting salary for a primary school teacher is USD 28 937, just above the OECD average of USD 28 523. However, after ten years of experience, Swedish primary school teachers earn USD 32 182 (the OECD average is USD 34 968); and at the top of the pay scale, Swedish teachers earn USD 38 696 compared to the OECD average of USD 45 100. At the same time, the total statutory working time for teachers in Sweden is one the highest in the world, although the ratio of students to teaching staff in primary and secondary education is far below the OECD average. Sweden is implementing reforms to raise the status of the teaching profession by focusing on continuous professional development and by launching a campaign to attract teachers. Additional resources of up to SEK 3.8 billion have been allocated in the 2011 budget bill to "break the downward trend in learning outcomes among Swedish pupils" (Swedish Government, 2011). In the bill, the government also proposes to explore the prerequisites for implementing a state-financed incentive payment.

Source: OECD (2012).

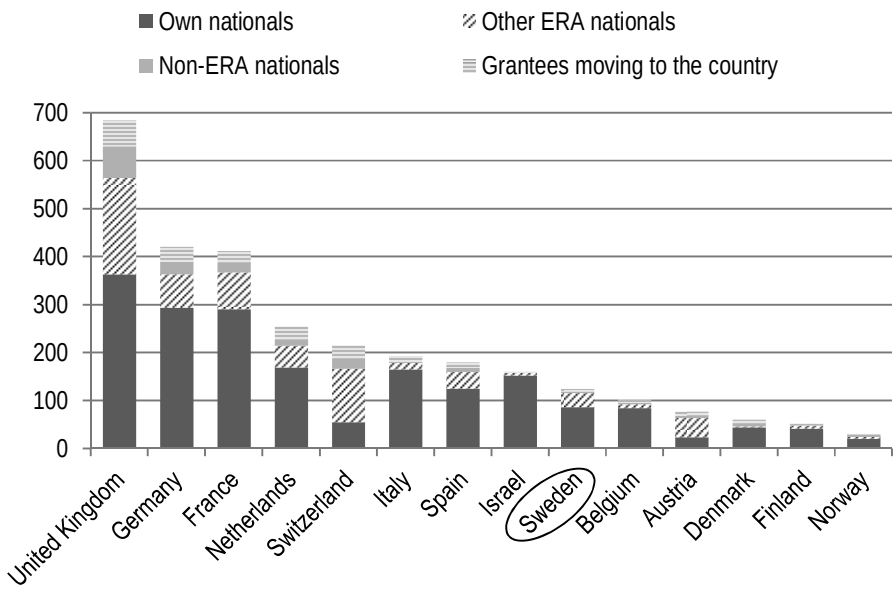
Public provision of adult education (AE) at compulsory, secondary and tertiary levels is relatively generous (Stenberg, 2012). Since 1974 employees have a legal right to leave for study purposes, as well as to reinstatement with equal working conditions and wages. Since 1969 municipalities must by law offer AE at compulsory and upper secondary level. Publicly funded schooling is free of charge and full-time students are entitled to some degree of financial support. Those undertaking AE on at least a 50% full-time basis are entitled to study allowances. However, the OECD (2011b) points out that the dual system of employment protection legislation (EPL), with high protection for workers with permanent contracts but low protection for workers with temporary contracts, could hinder investment in human capital, given that firms have less incentive to provide temporary workers with on-the-job training. Sweden also helps disadvantaged populations to access science and technology education by offering science classes to persons with grades that are too low to enter university. After completing one year (and passing the exams) a place at university in natural science or engineering is guaranteed.

3.5.2. International migration of human resources for S&T and innovation

Migration of highly skilled human resources contributes to the creation and diffusion of knowledge. An inflow of talent can increase R&D and economic activity, improve knowledge flows and collaboration with sending countries, and lead to firm and job creation by immigrant entrepreneurs. In addition to economic incentives, other factors contribute to flows of the highly skilled, such as high-quality research infrastructure and the opportunity to work with "star" scientists. Language and quality of life issues are also important considerations (OECD, 2008).

Swedish universities could profit from higher mobility of human resources within Sweden as well as internationally. As mentioned above, 58% of Swedish faculty members have their PhD from their own university (Aghion *et al*., 2008), owing to a model of lifelong employment after a few years at an HEI instead of a tenure track model. High-quality inward mobility may also be an issue. For example, the proportion of non-Swedish-born Swedish ERC grantees is comparable to that of other prominent European science nations such as Germany, France, the Netherlands and Spain, each of which has around 30% of internationals among their ERC grantees. However, Figure 3.21 shows how effective Switzerland, Austria and the United Kingdom have been in attracting top international researchers who obtain ERC grants, mostly long before they win a grant (see also Edler *et al*., 2012).

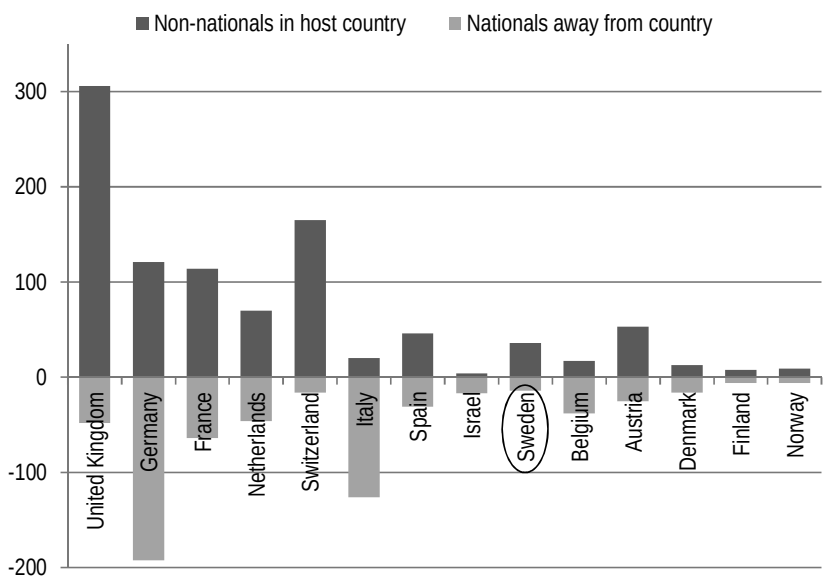
Figure 3.21. Origin of grantees in ERC Starting & Advanced Grant calls, 2007-11



Source: ERC data information, September 2012.

Figure 3.22 shows that the flow of ERC grantees in and out of Sweden is significantly lower than in comparator science countries, such as Switzerland. Still Sweden has at least a net gain of excellent researchers, attracting more than twice as many nationals as Swedish nationals leaving the country. For Italy, Germany and Belgium the difference between non-nationals in the host country and nationals away from the country is clearly negative, while in Denmark, Finland and Norway, the in and out flow results in neither a net gain nor a net loss.

Figure 3.22. International exchange of researchers in ERC Starting & Advanced Grant calls, 2007-11



Source: ERC data information, September 2012.

A global survey of scientists in four disciplines (Franzoni *et al*., 2012) places Sweden fifth among 16 countries in terms of where respondents were at age 18 ("country of origin"). Switzerland leads with more than 56% of scientists who were not in the country at that age (Germans form one of Switzerland's most geographically concentrated groups). Canada and Australia form the next groups (both around 45%) followed by the United States (38%) and Sweden (38%). While these are survey results, not national statistics, the numbers suggest that Sweden is internationally more attractive than Denmark or Germany. Another survey asking researchers working across Europe about preferred countries for future mobility ranks Sweden in the middle group, with Switzerland and the Netherlands well ahead (Reinstaller *et al*., 2012, pp. 112 *ff*.).[18]

Another aspect of mobility concerns the attractiveness of studying in Swedish universities for foreign students. Since 2011, students from countries outside the European Economic Area (EEA) and Switzerland have been charged the full costs of their chosen study programme. Previously, they were treated like their Swedish counterparts and did not have to pay tuition fees. This reform has further spurred discussions of *mångfald* (diversification of the student body), including its internationalisation. Recent data from the Swedish National Agency for Higher Education show an almost 90% fall in new entrants from non-EEA countries following the introduction of tuition fees (Table 3.15). As tertiary-level overseas students can represent an important source of human capital, the impact of this move will need to be closely monitored.

Table 3.15. New entrants to Swedish higher education institutes from abroad, 2010 and 2011

	2010 autumn intake	2011 autumn intake	Percentage change
EEA countries and Switzerland	1 391	1 763	+27
Other countries	7 564	1 601	-89

Note: Data exclude exchange programme students (who are not subject to tuition fees, irrespective of country of origin).

Source: Swedish National Agency for Higher Education (2012).

3.5.3. The status of women in Swedish research

According to *Gender Challenge in Research Funding* (European Commission, 2009b), Sweden is classified as a country with a very active policy to strengthen the representation of women in science and is considered, along with the other Nordic countries, among the global leaders in gender equality. In 2007, around 34% of all Swedish researchers were female compared to an EU average of 32%. However, the hierarchy of R&D occupations shows a clear traditional picture: for all countries and all sectors, the share of male researchers (at the top of the hierarchy) is larger than that of female researchers. On the bottom of the hierarchy the share of female technicians and other support staff exceeds the share of males.

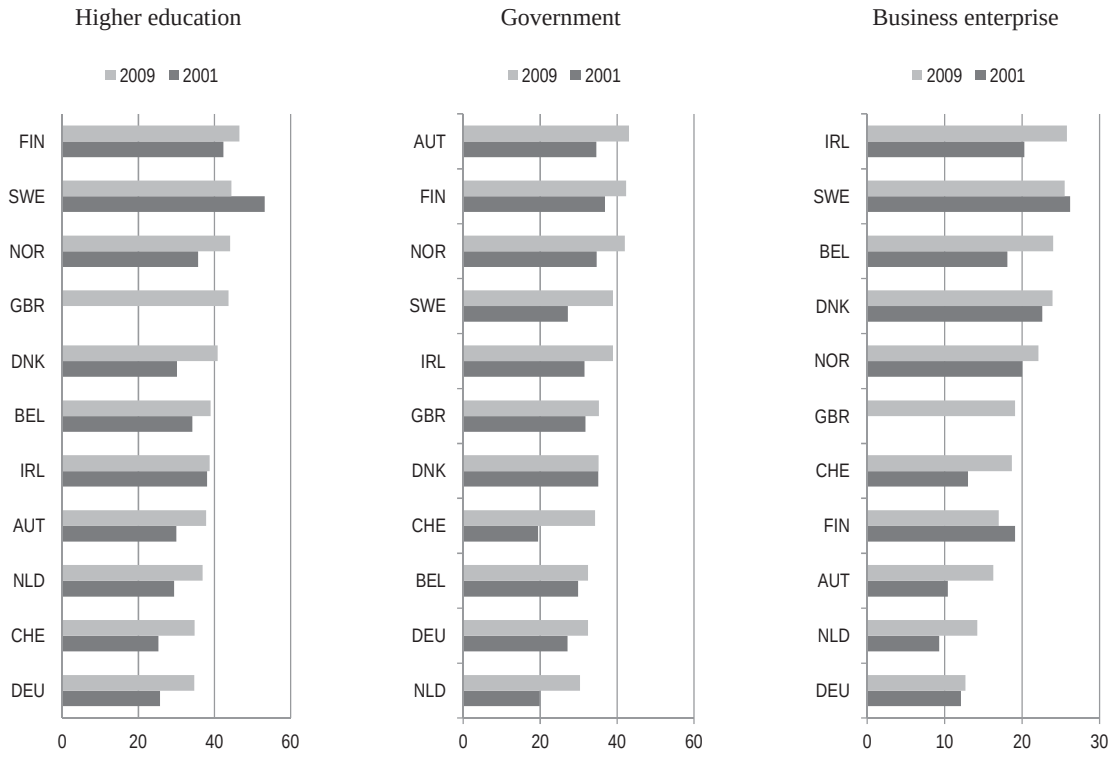
In terms of the share of female students in tertiary education, Sweden's overall share of 60.3% in all fields is above the EU27 average of 55.3%. The share of female students in science and engineering in Sweden is 34.0%, also above the EU27 average of 30.1% (Eurostat, 2011, p. 62). A notable increase in the proportion of female PhD graduates occurred between 2001 and 2008 in nearly all European countries. Norway (+10.4 percentage points), the Netherlands (+10.2 percentage points), Belgium (+10.1 percentage points) and Germany (+6.6 percentage points) show the biggest increases; Sweden's share rose from 39.2% to 44.9% (+5.7 percentage points). The compound annual growth rate of

PhD graduates, by sex, shows that in most countries the growth rate for women exceeds that for men over the period.

In general, the gender gap is closing slowly in the public sector, with the share of women in total research employment growing at a faster rate than the share of men in most European countries. However, major inequalities persist in top academic positions and in the business sector. Sweden ranks high (Figure 3.23) in terms of female researchers in higher education (45%) and in the government (39%). Nonetheless, the percentage of female researchers in higher education was significantly higher in 2000 than in 2009 (at 53%, Sweden ranked first in 2000). The proportion of female researchers in the business sector decreased by less than 1 percentage point between 2000 and 2009, while it increased by almost 12 percentage points in the government sector.

Figure 3.23. Female researchers (headcount) by sector

Females as a percentage of total, 2001 and 2009 or nearest year



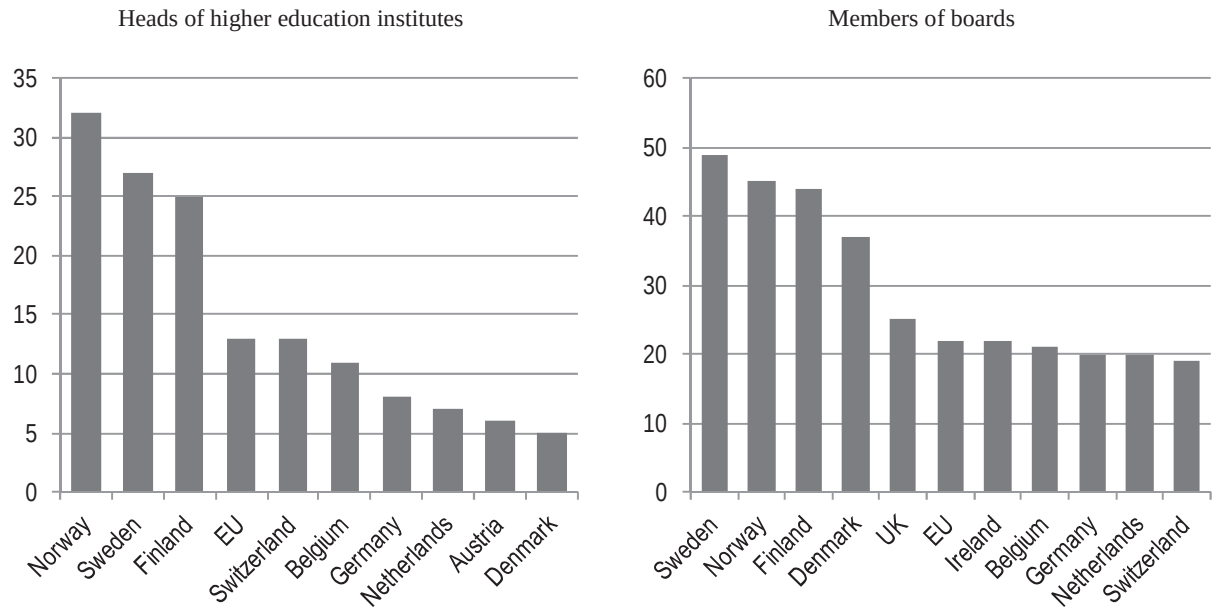
Source: Main Science and Technology Indicators, 2012/1

In Europe, despite the many cross-country differences, female researchers in the higher education sector are more concentrated in medical sciences (Sweden ranks at the top with a 51% share of female researchers in 2008) and less concentrated in engineering.[19] The same is true for Swedish female PhDs and their respective fields. Only 29% of graduates in engineering, manufacturing and construction in 2008 were female. Compared to the EU average (26%) and to the Netherlands, Ireland, Finland, Germany, Denmark, the United Kingdom and Switzerland, Sweden and Norway have the largest shares in this field. Only Belgium (30%) exceeds Sweden. The largest shares of women PhDs as a percentage of total PhD graduates in Sweden are in education

(78%), health and welfare (60%), agriculture and veterinary medicine (56%), and humanities and the arts (52%). Sweden scores lower than the EU average in the humanities and the arts, the social sciences, business and law, and science, mathematics and computing.

In Sweden women hold 18% of academic positions (equivalent to full professor). Only Finland, Switzerland and Norway have a higher proportion (23%, 22%, and 18%, respectively). Norway, Sweden and Finland also rank at the top in terms of women as heads of higher education institutes and on boards (Figure 3.24). This stems from the obligation to have at least 40% of members of each sex on all national research committees and equivalent bodies.

Figure 3.24. Proportion of women in senior positions, 2007



Source: European Commission (2011), pp. 236 *ff*.

Notes

1 Note that 40% of services sector R&D falls under "R&D institutions".

2 The term cluster is used both for the national and for the regional level and the definitions, as often with clusters, are not overly clear.

3 SBA data, in Hytti and Pulkannen (2010). The SMEs are complemented by some 1 000 large firms that employ another million people (36.3%) and contribute 44.2% to overall value added.

4 SEK 15 billion translates into about EUR 1.5 billion. Austrian SMEs have around EUR 1.5 billion in R&D expenditures (Federal Ministry of Science and Research, 2012) provides more detailed information on concentration and shares).

5 Data provided by VINNOVA and sourced from the European Commission's E-CORDA database (https://webgate.ec.europa.eu/e-corda/). Data refer to the period from 2007 (the start of FP7) to 18 October 2012.

6 The remarkably good relative position of companies from countries that are otherwise not among leading innovators (*i.e.* Greece, Cyprus or Portugal) on some IUS SME indicators indicates the possibility of strong national biases.

7 Student numbers based on Inkinen (2011).

8 The comparisons in Ljungberg *et al.* (2009) generally show, unsurprisingly, a big rift between the young and the established universities. The latter have considerably higher budgets, better student-teacher ratios, are better research performers, have some critical mass and can attract more industry money.

9 The authors aim to refute the idea that Swedish academia has an abundance of means for blue-sky research. They show that a lot of the available resources – at least in a technical university – encourage and fund "useful" applied research.

10 This message comes with two caveats: data are for 2003 and some countries with "more expensive" researchers have a higher share of public research institutes.

11 The Austrian Science Fund FWF has compared council budgets per inhabitant: the Swiss SNF leads with EUR 80, followed by the Academy of Finland with EUR 60. The Dutch NWO has more than EUR 40, while the FWF has only a little more than EUR 20. Vetenskapsradet alone can spend more than EUR 40 per inhabitant, and, together with the budgets of Formas, FAS, RJ and parts of the semi-public foundations, this sum is higher by at least 50% (source for the non-Swedish councils: FWF).

12 TTOs are often called TLOs with the "L" standing for licensing. However, Swedish universities do not have much intellectual property to license out.

13 *www.ri.se/en/about-rise/9-challenges.*

14 Industry associations provide information, training and other services to their member companies in their specific industry, sometimes on innovation-related

issues. They also seek to represent the views of their industry in policy debates. Employer trade associations enter into collective agreements with trade unions on issues such as salaries and the general terms and conditions of employment.

15 For more information on these actors, see Vetenskapsrådet (2012).

16 For more information on SISP, see *www.sisp.se*.

17 PISA is the acronym for the *Programme for International Student Assessment*. TIMMS is the *Trends in International Mathematics and Science Study* and PIRLS is the *Progress in International Reading Literacy Study*.

18 See also results of the EU MORE study (IDEA Consult *et al.*, 2010).

19 No data are available for the Swedish government sector.

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Chapter 4

Role of government

This chapter examines a range of public activities that influence the Swedish innovation system. It begins by charting the evolution of Sweden's science, technology and innovation policy before highlighting a number of issues of concern around public governance arrangements and innovation policy. The Swedish system is characterised by a multitude of strong intermediary organizations operating in a multi-level governance setting. While the national level remains dominant, the regional and, most notably, the European levels are increasingly relevant. The possible implications of current arrangements for national priority setting are discussed. The chapter looks at a number of substantive strategic innovation policy tasks that correspond to innovation system "functions" which policy should enable. These include supporting business innovation, facilitating access to risk financing, nurturing skills for innovation, spurring demand for innovation and fostering excellence and critical mass. Mindful of Sweden's national context and of policy practices in other leading countries, each section concludes with a discussion of promising policy directions.

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

4.1. The evolution of Sweden's science, technology and innovation policy

Innovation policy is a relatively new phenomenon in Sweden, as it is in all OECD countries. It has its antecedents in earlier technology policy and some aspects of industry policy and science policy.[1] Belief in the role of technical research for economic growth has long been strong in Sweden, and technology funding, before the establishment of technology policy, was part of industrial policy. Technology policy had its start in 1940, when the Malm Committee proposed a group of organisations for supporting technological change (Lundin and Stenlas, 2010, p. 19). The most important institutional development at that time was the Technical Research Council (TFR), Sweden's first research council (Arnold *et al.*, 2008a, p. 24). TFR was responsible for financing scientific research, but it also had overall responsibility for the development of technical research, including the initiation of specific activities and the transfer of results. Allocation mechanisms were dominated by academics, a feature of Swedish R&D policy. In contrast to many other industrialised countries, no specific public research institutes (PRIs) were established and financed by TFR.[2] Instead, Swedish universities were favoured as the prime location for research in the more technological disciplines.[3]

For many years, TFR had a central role in policy execution and also set standards that remained important for successive agencies, including the choice of universities as providers of knowledge and human capital (Arnold *et al.*, 2008a, p. 23). Even today, industrial PhDs and university-based centres are an important part of the Swedish landscape. Persson (2008, p. 15) describes TFR's mission as part of the Social Democrat government's industrial policy: to spur productivity and rationalisation but also to influence technological agendas in important economic sectors. This political agenda led to the establishment of long-term "development pairs" between big industry and state infrastructure providers (Lundin *et al.*, 2010). Under this overall industry policy, specific industrial sectors often received long-term funding for thematic programmes, sometimes for a small number of actors. As a result, industry played a strong role in defining the scope and areas of public (funding), and a large share of subsidies went to academic researchers for applied research projects, often in the context of a "grand challenge" or an important mission: nuclear energy, power transmission, housing, weaponry, telecommunications, trains, etc.

Box 4.1. The role of STU and NUTEK in the success of Sweden's mobile telecommunications

The story of telecommunications switches and Ericsson's success in mobile communications can be partly attributed to the long-term steering and funding of often university-based research by STU and later by NUTEK. The effects are well documented. STU was much more deeply involved in the shaping of individual projects and consortia than technology funding agencies today. It had a strong influence on research and higher education policy in Sweden "to cope with the dramatically new needs of the electronic age" in the late 1970s and 1980s (Arnold *et al.*, 2008a, p. 55; p. 59 lists individual programmes). The provision of a long-term framework for building trust and providing orientation proved as important as the outputs. Important technical results were achieved, but the main impact seems to have been the build-up of a strong human capital base in the funded university groups. Their size and number grew as did the number of PhDs at Ericsson and Televerket/Telia (Arnold *et al.*, 2008a, p. 70 and pp. 82 *ff.*). This amounted to a co-evolution of academic capacities and industrial development. The long-term view suggests STU's and NUTEK's strong impact on Ericsson's "first comer" profits in the digital telecommunications market around 2000.

Technology funding as a part of industrial policy remained important through the 1960s and into the 1970s. In 1968 the Board for Technical Development (STU) was created as the government agency to replace TFR and was made responsible for industrial policy. A new Ministry of Industry also had at its disposal a number of policy tools, such as a national investment bank and the Swedish Development Company. STU combined technology funding to industry, university research, sector institutes and consortia (through grants and loans) with a more integrated policy-steering approach.[4] A prominent example of its success (and that of its successors) is provided in Box 4.1. However, the story is one that seems difficult to replicate today. Today's framework and funding landscape does not appear favourable to such large and complex interventions.

In the mid-1980s STU had 14 priority areas, ranging from genetics to ICT and metallurgy (Herman, 1984, p. 31). During this time, there was constant discussion about how to set priorities, with an emphasis on the balance between (often directed) applied research funding and (sometimes targeted but mostly bottom-up) basic research. In the 1980s academic researchers in particular urged more long-term basic research and argued against the compartmentalisation of research funding along the lines of sector policies (Persson, 2008, p. 18). These discussions influenced the distribution of tasks and funding among the various research councils but also the directions taken by STU. The boundaries – or division of labour – between funding of applied and basic research became more marked as the "sector principle" weakened. The gradual ascendency of science policy and the concomitant weakening of technology policy has resulted in the relatively minor priority attached to innovation policy today.

NUTEK succeeded to STU as the result of a merger of STU with another government agency for industrial policy. It was created in 1991 and parts of the STU budget were redirected to a newly founded technical research council. NUTEK continued STU's record of large-scale public-private partnerships (PPPs) for developing new technologies in fields such as nuclear energy, telecommunications and military aircraft (Bitard *et al*., 2008, p. 266). It also continued to focus on universities as core recipients of funding, with the prominent competence centre (CC) funding as the flagship programme for science–industry consortia on the basis of strict peer review procedures. Industry co-funding also became more important in other NUTEK programmes.

Sector policies became counterproductive when they amounted to preserving non-competitive structures. Some sector policy approaches were formally abandoned in 2001 (Growth Analysis, 2011, p. 48), although similar initiatives were launched around 2004 (Bitard *et al*., 2008, p. 270). These still exist in various pockets of the organisational structure, as policy often addresses certain sectors and specific agencies abound. For the early 2000s, Bitard *et al*. (2008, p. 269), speak of "problematic sectoral allocation of R&D, policy-makers have generally ignored the institutionally induced lock-in of R&D resources and results to large firms in traditional sectors. Public agencies have even supported R&D in traditional sectors to a large extent …", and have therefore maintained traditional production structures.[5]

During the 1990s, the innovation paradigm emerged, along with attention to consortia and a stronger focus on SMEs and regional development and growth. This led to the establishment of VINNOVA in 2001 (Persson, 2008, p. 20 *ff*.). In parallel NUTEK was in charge of the STU legacy of thematic programmes (Arnold *et al*., 2008a, p. 60). A few years earlier the foundations created through the abolition of the wage earner funds had entered the scene and EU accession came in 1995. For the last ten years, the R&D support landscape in Sweden has been is quite stable – and somewhat crowded – with

some new initiatives and organisations mainly in the areas of entrepreneurship and regional innovation. It seems at least debatable that recent developments and arrangements have resulted in a sufficiently systemic and coherent policy approach as regards innovation.

4.2. Main policy actors

Innovation is supported at all levels of governance, as it is in almost all OECD countries. However, the strong concentration of resources at the national level and relatively weak regional competencies mean that the Swedish government occupies a strong position: targets, guidelines and the allocation of resources are largely set at the national level. Ministries, which are relatively small organisations by OECD country standards, design overall policy, administer mid-term budgets and monitor progress. A multitude of agencies are linked to the ministries and perform many government functions, including detailed policy formulation. This section describes the main innovation policy ministries and the most important agencies. It also covers various state and semi-public foundations that play a prominent role in supporting research and innovation activities.

4.2.1. Government ministries

Like most OECD countries Sweden has two main government ministries responsible for science, technology and industry (STI) policy:

- The *Ministry of Enterprise, Energy and Communication* has a number of important agendas. In terms of this review, it is responsible for mainstream innovation policy and a number of instruments to improve regional innovation systems. However the nine main responsibilities of the ministry – business development, competition, electronic communications, energy, ICT, postal communications, regional growth, tourism and transport – do not include innovation, which is mentioned only as part of the broader business development agenda.[6] Far from being a cross-cutting government issue, innovation policy is not even a strong field in the ministry. The ministry is responsible for 24 government agencies, including Tillväxtverket, VINNOVA, the Patent Office, the Transport Research Institute and the National Space Board.
- The responsibilities of the *Ministry of Education and Research* include schools, universities and science/research policy. The current minister also acts as deputy prime minister. Education and research constitutes a policy area but innovation does not (out of a total of 17 areas).[7] The minister of education is the lead minister on all questions to do with research and can use his remit to co-ordinate the overall research and innovation policy field. Overall the ministry has a strong role in this area and has provided ample and stable funding streams for councils and universities. It also has a number of operative government agencies, including the Swedish Research Council (Vetenskapsradet, VR). In addition, the Swedish National Agency for Higher Education acts as the central government agency for matters concerning higher education.

As in many countries, the *Ministry of Finance* has a strong influence on government strategy and policy making. The ministry traditionally focuses on macroeconomic policies and sees innovation as deriving from macroeconomic stability, sound public affairs and efficient competition legislation (Tillväxtverket, 2012, p. 23). Other

ministries still have sectoral approaches and use specific sector agencies to develop their respective research and innovation agendas. The *Ministry of Defence* has a strong tradition in R&D and innovation-oriented procurement. Though defence-related research shrank during the 1990s and 2000s, it is still much greater than in other smaller European countries.[8] The Swedish Defence Material Administration (FMV) and the Swedish Defence Research Agency (FOI) are important government agencies in this respect. As an R&D-performing organisation, FOI has around 1 000 employees and provides defence and security-related results, mainly to the public sector but also to the private sector and even to foreign customers (FOI, 2010, pp. 20 *ff*.). The *Ministry of Health and Social Affairs* and the *Ministry of the Environment* both have their own research funding councils, FAS and FORMAS, which are described below.

4.2.2. VINNOVA – the innovation systems agency

VINNOVA, the Swedish Governmental Agency for Innovation Systems, is a key public actor for innovation. Founded in 2001 to succeed NUTEK, its overall goals are the promotion of sustainable industrial growth, the renewal of industry and the public sector, and the development of internationally competitive knowledge through world-class and relevant research (VINNOVA, 2012, p. 9 *ff*.). With an annual budget of about EUR 220 million, VINNOVA will have to work hard to reach these ambitious goals. In comparison, Austria and Finland also emphasise improving innovation systems and fund firms through dedicated agencies. However, the Austrian Research Promotion Agency (FFG) has more than twice VINNOVA's budget for funding and Finland's Tekes, an even more dominant actor, has a budget three times higher (Table 4.1).[9] While Sweden also has a broad array of other funding agencies (described below), their missions focus on specific themes or academic research and lack VINNOVA's broad innovation system perspective.

Table 4.1. Innovation system agencies: VINNOVA compared to Finland's Tekes and Austria's FFG

	VINNOVA	Tekes, Finland	FFG, Austria
Approximate budget (EUR)	220 million (2011)	600 million (2011)	550 million (2010)
Direct budget appropriations for firms; Note: actual shares higher (centres, etc.)	30%	60-65%	65%
Budget per million inhabitants	24 million	110 million	65 million
Share of funding for firms with fewer than 10 employees in overall portfolio of firms funded	Approx. 25% (VINNOVA estimation)	31% (2007-2010)	Approx. 15% (FFG estimation)
Share of funding for firms with fewer than 250 employees in overall portfolio of firms funded	66% (9% for 50-249)	65% (8% for 50-249)	46%
Significant funding of HEI/PRI (in consortia)	Yes	Yes	Yes
Number of individual programmes	Medium to high	Medium	Very high
Number of agencies with overlapping missions (but no system agencies)	Very high	Medium	Medium (regional actors)
Degree of co-design/finance with other agencies	Very high	Low to medium	Low
Claim to change the innovation system	High	High	Medium

Sources: Van der Veen *et al*. (2012), VINNOVA (2010, 2012), FFG (2011).

To meet its ambitious goals, VINNOVA has a large portfolio of instruments and programmes, including some high-profile initiatives. A number of proven VINNOVA forms of intervention date to NUTEK or even earlier, which leads some observers to note a discrepancy between the proclaimed systems change and the continued presence of traditional instruments (Persson, 2008, pp. 37 *ff.*).[10] VINNOVA often co-operates with other funding agencies and tries to foster multi-actor initiatives and programmes.[11] Overall, around 45% of the agency's budget goes to universities and 30% to companies (VINNOVA, 2012, p. 14). Nearly 60% of company funding goes to SMEs and several of VINNOVA's funding programmes are reserved for SMEs[12] (VINNOVA, 2012, p. 38 *ff.*). In addition to funding, the agency deploys complementary instruments, including foresight, to help shape expectations, create experimental settings, and develop pre-competitive standards.

4.2.3. Tillväxtverket – the regional development agency

The *Swedish Agency for Economic and Regional Growth* (Tillväxtverket) is another offspring of relatively recent agency reshuffling. Its mission is to foster sustainable growth in the Swedish economy. With around 350 employees on 11 sites across the country, Tillväxtverket is an important actor. Its main activities include fostering entrepreneurship (often with other public agencies) and promoting regional strategies in its role as management authority for the execution of the eight EU Structural Funds programmes. The agency supports co-operation between companies and assists in providing networks and information. Funding goes to many actors, including start-ups (Tillväxtverket, 2010). All in all Tillväxtverket supports thousands of individual projects and is the most important regional innovation policy player in Sweden. In addition to Tillväxtverket, the *Swedish Agency for Growth Policy Analysis* (Tillväxtanalys) undertakes background analyses of various kinds. Tillväxtverket's activities are covered more extensively below.

4.2.4. Research councils

The *Swedish Research Council* (Vetenskapsradet, VR) is the central funding source for grants for most scientific disciplines. It was created in 2001 as a merger of a number of discipline-oriented individual councils. It is run by a board and a director general. The annual budget amounts to some SEK 4 billion. VR has six councils which have their own budget lines, organise review procedures around evaluation panels and fund projects. The structure has been criticised for failing to integrate VR sub-councils (*e.g.* Arnold, 2008). The six councils are responsible for the humanities and social sciences, for medicine and health, for the natural and engineering sciences, for the educational sciences, for artistic research and for research infrastructures. Evaluation is carried out by both Swedish[13] and foreign peers. More than 6 000 applications are reviewed each year with an acceptance rate of around 20%. In the European context VR is a rather large organisation and ensures a meaningful competitive element in the financing of mainly university-based research. The VR budget for grants represents some 10% of overall university research funds. It does not fund positions. The big traditional universities, such as Lund, Uppsala and the Karolinska Institutet, are the largest recipients (Forskning.se, 2009, p. 13).

The *Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning* (FORMAS) acts as a research council for all matters related to the environment and sustainable development. Its mission is to combine scientific excellence and social relevance. The main priority areas are climate and energy, management of natural resources and the environment, urban and rural development, environmental technology

and new materials, and quality of life for humans and animals (Formas, 2008, pp. 9, 14). The funding portfolio includes mono- as well as multi-disciplinary projects, in both basic and use-oriented research. FORMAS has a budget of around SEK 900 million a year. Like VR it uses a mix of foreign and Swedish peers to review applications. A specific funding line, the Linnaeus Grants (see below), is provided together with VR support.

The *Swedish Council for Working Life and Social Research* (FAS) supports research in the fields of employment, work organisation, work and health, public health, welfare, care services, and social relations (Forskning.se, 2009, p. 6) with around SEK 450 million a year. Like VR it was created in 2001 as a merger of two smaller councils. Like FORMAS, FAS can fund applied and basic research. It also emphasises dissemination and knowledge transfer as well as in-house strategy development. It has adopted a two-stage evaluation process organised into specific committees. Funding instruments include projects, centres, personal grants, programme funding and a number of smaller instruments (see FAS, 2010, pp. 15 *ff.*).

4.2.5. State and semi-public foundations for scientific and mission-oriented research

Most of the foundations described below are the result of a political conflict earlier in Swedish history and the subsequent so-called "wage earner funds". They were originally intended to alter ownership structures in industry and were set up in a loose form in the early 1980s. These were dismantled a few years later and the allocated capital was used to finance different kinds of research and innovation activities. The resulting organisations are called the wage earner fund foundations. They are independent and have access to considerable resources (European Foundation Centre, 2009, pp. 96 *ff.*). The most important of these foundations active in research and innovation funding are described below.

The *Swedish Foundation for Strategic Research* (SSF), founded in 1994, provides funding for research in the natural sciences, engineering and medicine. It has a budget of around SEK 500 million and can fund persons, projects or research programmes. It has 200 current grants of various kinds, with centres and "framework grants", *i.e.* networks of academic researchers, accounting for most of the expenditures. SSF mainly uses international evaluators. Relevance is ensured though the integration of industrial partners in centres and consortia. The goals of the foundation are the creation of academic and economic value through research relevant to high-technology industries, graduates, scientific hotspots and international attractiveness (SSF, 2010, p. 2).

The *Knowledge Foundation or KK Stiftelsen* (KKS), also founded in 1994, has as its specific mission the build-up and intensification of research at the 17 smaller Swedish universities. This rather new second tier of higher education institution (see Chapter 3) was mainly established without research facilities. KKS provides the necessary grant-based resources. Its range of programmes includes joint industry-driven research projects with academic partners, industrial doctoral and post-doctoral financing, research centres that focus on commercially relevant topics, and research profiles that help universities establish a distinct research profile in certain areas (Johannesson *et al.*, 2009). This process gives new universities the chance to obtain the right to grant PhD degrees in fields in which they have demonstrated the ability to perform high-quality research. The universities – either the university leadership or senior staff – apply to structured competitive funding calls. The foundation can spend around SEK 300 million a year. KKS is therefore an important actor both for regional development and in discussions of

the roles and tasks of the Swedish university landscape. Both the foundation and the smaller universities argue that they can attract and serve industry, particularly SMEs, much better and more strategically and comprehensively than the older and larger universities. Evidence suggests that KKS has met with reasonable success (Johannesson *et al*., 2009, pp. 10 *ff*.; Melin *et al*., 2011). Evaluations show that some of the increased research in firms participating in KKS consortia can be attributed to the funding (KKS, 2011, p. 12; Johannesson *et al*., 2009). Larger firms such as Ericsson, Getinge, SAAB or SCA appear to have retained or strengthened individual non-metropolitan research centres in locations where KKS funds research that is relevant to their interests (KKS, 2011, pp. 23 *ff*.).

The *Foundation for Strategic Environmental Research* (MISTRA) has a budget of around SEK 200 million a year, mainly to fund research groups, with a view to solving major environmental problems and supporting environmental policies. The foundation strongly emphasises its use orientation, the inclusion of end users, and support for interdisciplinary research. Funding topics can come from MISTRA or from external sources. Pre-planning is supported, and the second stage includes a review of both the scientific and user value. A typical MISTRA programme with one main (mostly academic) contractor runs for 6-8 years with an annual budget of around SEK 10 million. About 40 programmes have received funding so far, with around 15 programmes running at any one time (MISTRA, 2011, p. 33). These thematic initiatives are complemented by smaller seed funds to test new ideas and two "MISTRA centres". MISTRA has quite ambitious funding/spending goals, with plans to increase them. Given its assets, this could lead to the (planned and possible) exhaustion of MISTRA's capital (MISTRA, 2011, pp. 29 *ff*.).

The aim of the *Swedish Foundation for Health Care Sciences and Allergy Research* (Vardal) is to improve human health and living conditions. With around SEK 60 million a year, Vardal supports research projects and networks in public health, paediatrics, ageing or neurosciences (Forskning.se, 2009, p. 17). Together with four or five other agencies Vardal used to run the Swedish Brain Power consortium to fight diseases such as Alzheimer's, Parkinson's or amyotrophic lateral sclerosis (ALS).

The *Riksbankens Jubileumsfond* (RJ) is a completely different type of independent research funding organisation close to the public sector. Founded around the 300th anniversary of the Bank of Sweden in the 1960s, RJ has an annual budget of more than SEK 300 million and focuses on larger, competitive grants in the social sciences and humanities (SSH) via projects, programmes and infrastructure. This is the consequence of its Statutes, according to which "precedence shall be given to areas of research whose funding needs are not as well provided for by other means". They also state that SSH should be seen as strategically important areas of research (Riksbanken Jubileumsfond, 2011, p. 9). This makes RJ the second SSH funding actor alongside VR. Evaluations are done mainly by foreign peers in review panels and competition tends to be fierce, with a current acceptance rate of 6%.

4.2.6. Sector (funding) agencies

The *Swedish Energy Agency* (Statens Energimyndigheten, STEM) is a large government agency with a number of tasks involving energy policy issues. Like VINNOVA, it belongs to the Ministry of Enterprise, Energy and Communication. As Sweden seeks to become a country with an ecologically and economically sustainable energy system, STEM has a key role in this important policy field. R&D is part of this broader portfolio

of activities, which includes funding of studies, initiatives and external and internal projects dealing with supply, conversion, distribution and use of energy in fields such as alternative motor fuels, transport, energy use in buildings, energy-intensive industries, biomass or electrical energy systems. STEM actively supports the development of new technologies[14] and can provide grants, counselling and soft loans. The current annual R&D budget is around SEK 1.1 billion. Around a quarter of funding goes to companies for shared-cost projects, another quarter to research institutes and sector organisations, and the remaining half to the university sector. SMEs and municipalities get large budget shares for projects (Tillväxtverket, 2010, pp. 40 *ff.*). The agency plays an active role in European and international networks and projects.

The *Swedish National Space Board* (Rymdstyrlsen, SNSB) provides the Swedish contribution to the European Space Agency (ESA) of SEK 120 million a year and funds national programmes with an additional SEK 60 million. It can distribute grants for space research (from blue-sky to more user-oriented projects), technology development (specifically for remote-sensing activities) and can initiate research in these areas (Forskning.se, 2009, p 11). It oversees the Swedish space industry which consists of around 30 companies of different sizes, including RUAG and Volvo Aero.[15]

The *Swedish Environmental Protection Agency* has around SEK 100 million for support of interdisciplinary research on environmental protection and nature conservation, and the *Swedish Radiation Safety Authority* is an environmental agency charged with nuclear safety issues and has a comparable research budget.

4.3. Public governance: Agenda-setting, co-ordination and evaluation

Governance refers to the set of publicly defined institutional arrangements, including incentive structures and norms, that shape the ways in which various public and private actors involved in socioeconomic development interact when allocating and managing resources for innovation. Co-ordination is a critical feature of governance, but also a challenging one for all governments, as they encounter a mix of imperatives when seeking better co-ordination of innovation-related policies across ministries and agencies. Co-ordination can be fostered at different points in the policy cycle. For example, the formulation of strategic, long-term policies and visions that set the direction for priority setting can be instrumental in agenda-setting processes. Co-ordination can also be achieved in implementation processes, for example through joint programming (OECD, 2012a).

Governance has both vertical and horizontal aspects. The former refer, for example, to co-ordination between a ministry and its delivery agencies and the latter to inter-ministry and inter-agency relations. These two aspects are discussed below in the Swedish context. The issue of multi-level governance, *i.e.* the relations between national, regional, and, increasingly, European governance levels, is covered in later parts of the chapter.

4.3.1. Vertical co-ordination: agenda-setting and priorities

Swedish ministries are small and have many, often large and relatively autonomous agencies. This means that the ministries exert rather weak governance on agencies. Furthermore, agencies play a strong role in policy design: they define and develop their specific functions in the innovation system as well as the appropriate instruments. Individual agencies have their own intelligence and strategy departments and create their

own world view. They also often team up to influence government policies, to prepare concerted input for research bills and other occasions (Energimyndigheten *et al*., 2012) or to push forward international strategies (Svedin, 2009).

Some funding agencies and funding councils have defined priority areas; for example, FAS, FORMAS and STEM have identified certain topics (FAS, 2011, pp. 11 *ff.*; Formas, 2008, pp. 25 *ff.*; Swedish Energy Agency, 2009). However, there are large numbers of priority areas, many with considerable bottom-up input and at best mid-sized budgets for individual topics. The ability and readiness of the research councils to make plans, to prioritise and act as agents of change have been strongly criticised. Sandström *et al.* (2008) and Arnold (2008) see VR, FORMAS and FAS as conservative organisations that prefer small-scale activities on established topics and do not act as agents for change. The ability of the research councils to identify strong priority areas is therefore somewhat questionable. These sources also criticise the strong dominance of academia in the governance structures of the research councils and elsewhere. Nonetheless, the Swedish research councils employ approaches similar to those of research councils in other countries that also rely on a limited, proven set of instruments and are also firmly in the hands of academics.

The Swedish presidency of the European Union in 2009 saw the publication of the Lund Declaration, which called on European research to focus on the Grand Challenges of our time and to move beyond "current rigid thematic approaches". This was an important push to introduce the "Grand Challenges" concept at the European level but has perhaps had less impact at the national level. The current policy trend is to undertake a multitude of medium-sized activities and to abstain from larger policy missions. Sweden clearly has a proud tradition of larger-scale initiatives involving long-lasting public-private partnerships (see Arnold, 2008a; Dahmén 1991; or the contributions in Edquist *et al*, 2000 and Lundin *et al*., 2010). However, the framework conditions have changed, and some of the larger Swedish initiatives of the 1970s and 1980s were not particularly successful. As a consequence, while Europe's Grand Challenges are to be addressed boldly and selectively, Swedish policy makers at home seem reluctant to seek new ways of tackling grand challenges on a national level.[16] Even so, the "long-term greening" of the economy and changes in the energy supply and consumption patterns may inspire new and larger-scale innovation policy efforts than those currently being made.

Four-year research (and innovation) bills

Every four years the Swedish parliament decides on a bill to allocate and structure public research and innovation spending and to set priorities in a mid-term perspective. This valuable planning and financing instrument has existed since 1982 and sets a planning rhythm for all ministries, agencies and beneficiaries. It has led to further multi-annual planning instruments covering the main public R&D budget lines. This is important as long-term views and attitudes have been shaped or influenced by these regular planning exercises. Similar mid-term horizon exercises exist in other advanced countries, such as Switzerland.

The 2008 Research and Innovation Bill constituted the framework for public R&D spending for 2009-12. For the period, more than SEK 116 billion has been allocated, a somewhat larger budget than in preceding bills for both basic university appropriations and funding agencies. The universities get half of these funds as direct appropriations, approximately SEK 14 billion a year. Nearly SEK 8 billion is allocated through research

councils and another SEK 5 billion through government agencies. Defence-related public research activities accounted for approximately SEK 2.2 billion a year (Growth Analysis, 2011, p. 26).

The main focus of the bill is on specific additional programmes and instruments. First, it introduced a competitive funding element in university financing, so that indicators are used to allocate an additional SEK 1.5 billion and a 10% share of traditional funding (see Box 3.6 in Chapter 3; and university chapter, Swedish Government, 2008, pp. 51 *ff*.). Second, the main funding councils and agencies obtained higher basic budgets. A third funding element constituted a new form of budget allocation in Sweden: 24 strategically important areas for competitiveness and growth were defined and received earmarked funds, most of them in the broad fields of medical research, new technologies and climate research. The universities are the main direct beneficiaries, with the main public research councils and agencies entrusted with planning and administration. The extra funding that came with the priorities was considerable as a whole but rather small for each priority;[17] larger targeted resources were provided during the crisis for threatened fields such as the passenger car industry.[18] The extra funding was accompanied by an orchestrated co-ordination effort by the funding actors. This process is an example of the pattern of mid-sized instruments being delivered by a large number of mid-sized and well-co-ordinated – even too co-ordinated – agents providing medium-sized budgets to a large number of priority fields.

Apart from the additional funds, the 2008 bill also focused on stronger commercialisation incentives for universities and announced the setting up of innovation offices at HEIs (see below). It also initiated the restructuring of the public research institutes that led to the creation of the RISE holding (see Chapter 3). At the time of finalising this review, the Ministry of Education and Research had just published its new Research and Innovation Bill for 2013-16. The bill's main elements are set out in Box 4.2 and show considerable continuity with the directions set in the 2008 bill.

Box 4.2. Main elements of the new Research and Innovation Bill 2013-16

The proposal for the Research and Innovation Bill 2013-2016 was recently presented and proposes an additional SEK 4 billion for the period on top of the current budget appropriations for research and innovation. This is a continuation of the expansion strategy initiated in the 2008 bill. The main beneficiary is academic research and HEIs will obtain considerable additional funding. Stepwise the additional annual funding will reach SEK 900 million by 2016. These extra means will be distributed on the basis of quality criteria and more peer review. This procedure will also apply to a higher share of existing university block funds. These incentives will be accompanied by two major new VR funding programmes to boost frontier research, mainly to attract top young researchers to Sweden. Thematically, the life sciences will be strengthened and critical mass is to be built through initiatives such as the SciLifeLab in Stockholm, which will receive SEK 200 million, a third of the special life sciences appropriations of SEK 600 million. Such initiatives will help offset recent losses in industrial research facilities. Another academic initiative, the ESS and MAX IV large infrastructures in Lund, will also obtain generous funding. Further additional innovation funds will be channelled to VINNOVA's "strategic innovation area" programmes, to some strategic areas and to innovation offices at universities.

Source: Ministry of Education and Research (2012), *Regeringens proposition 2012/13:30, Forskning och innovation*, Stockholm.

National innovation strategies

National innovation strategies have been drawn up in many OECD countries over the last decade or so. They typically involve wide consultation and deliberation and provide diagnostic overviews of innovation system strengths and weaknesses and the opportunities and threats that are likely to arise in the near future. In 2004, the Ministry of Industry, Employment and Communications (predecessor of the current Ministry of Enterprise, Energy and Communication) and the Ministry of Education and Research jointly published the "Innovative Sweden" strategy. It was drawn up by a working group of representatives from several ministries and involved canvassing the views of the business sector and the trade union movement, as well as representatives of the research and education community and public agencies. The strategy acknowledged Sweden's strong position in innovation while drawing attention to the changing global environment and the potential implications. It proposed to set an "offensive agenda" that would allow Sweden to improve the conditions for innovation and "guard its lead".

The strategy's coverage focused mainly on issues in the education, research, trade and industry policy areas, but it also advocated a broader policy framework for innovation, *e.g.* much emphasis was placed on promoting renewal and efficiency in the wider public sector through innovation. The strategy emphasised the need for concentrating research and education efforts in national "profile areas", defined as globally "attractive environments" with interesting future prospects. However, it declined to identify particular areas, preferring instead to call on the business sector, research and education actors and other public actors to prioritise their efforts collectively to achieve sufficient critical mass in private and public investments on research, education and enterprise.

The strategy was vague on the details of implementation: the research bills were seen as one channel for "gradual implementation" and further consultation and contacts with different sectors of society were to continue during the implementation phase. An interministerial Innovation Policy Council was established for this purpose but was short-lived. Overall, the messages of the strategy were broadly welcomed but follow-up measures generally failed to meet expectations.

During 2011-12, the Ministry of Enterprise, Energy and Communications orchestrated a process of broad consultation on a new innovation strategy for Sweden. The resulting report, "The Swedish Innovation Strategy", was published in October 2012, just as this review was being finalised. It was drafted on the basis of a long and intense preparatory phase, including all relevant ministries, many agencies, societal and economic actors. A number of actors prepared position papers to define their individual as well as common positions as part of the process and therefore added to the stock of valuable knowledge and common understanding.

The strategy's main line of argumentation is the need to adopt a broad innovation concept in designing and implementing innovation policy. It calls for a dedicated effort to bring innovation policy closer to the centre of policy making and to strengthen the horizontal links across governmental work. As in European STI policy making, 2020 serves as the "horizon", while grand societal challenges such as health, food, sustainability and climate are the *raison d'être* of this policy effort. The strategy seeks to help empower people and organisations to become more innovative in order to serve society better, with growth and new jobs as a consequence. Collaboration on all levels and between all kinds of partners is viewed as at least as important as competition.

Six elements lie at the heart of the strategy: human resources, the research and higher education system, infrastructures and framework conditions, the business sector, the public sector and finally the regions. For all six elements a core goal and sub-targets are stated, some in the form of qualitative goals (Ministry of Enterprise, Energy and Communications, 2012, pp. 22 *ff.*). While these goals and targets are further elaborated and lead to lists of actions, they are neither quantified nor precisely stated, and proposed activities are often not addressed to specific actors.

Within all these tasks the strong focus on public-sector innovation is very valuable; the state addresses its own procedures, norms and institutions and asks where to improve in order to make the country a better place for innovation. This kind of discussion can build on existing Swedish strengths and be a role model for other public administrations. This is further discussed in section 4.10.

In sum the Innovation Strategy is an important step towards a more integrated and encompassing innovation policy and empowers a policy field that is traditionally weak when compared to macroeconomic policy or higher education policy. However it is just a first step and calls for much more concise follow-up activities. The close link to the new Research and Innovation Bill 2013-2016 is only one such activity and the linking to other strategies, *e.g.* in energy policy, is another.

Further recommendations concern the formulation and execution of larger missions. The government should consider introducing a few high-profile, large-scale initiatives in addition to the many, often parallel, medium-sized policy making and funding activities. This recommendation does not necessarily conflict with Sweden's deeply rooted consensus principle as past initiatives have shown. Consensus can also be achieved on large initiatives. The government could use the new innovation strategy and successive planning activities to formulate a small number of large initiatives to promote innovation in Sweden. Such an approach, including the creation of larger centres (see section 4.8), could be inspired by the European Grand Challenges. In this context, the "greening" of funding programmes (direct funding, clusters, networks, etc.) and agencies should continue, as climate change and sustainability issues will remain on the agenda and will continue to create considerable market opportunities. Such initiatives should be linked to demand-side incentives such as innovative procurement. Sweden's ambitious policy goals, *e.g.* on reduction of CO_2 emissions, could serve as a booster.

4.3.2. Horizontal co-ordination

Given the strong role of agencies, horizontal co-ordination of innovation policy in Sweden should be investigated at two levels: the ministry level and the level of the agencies.

The ministry level

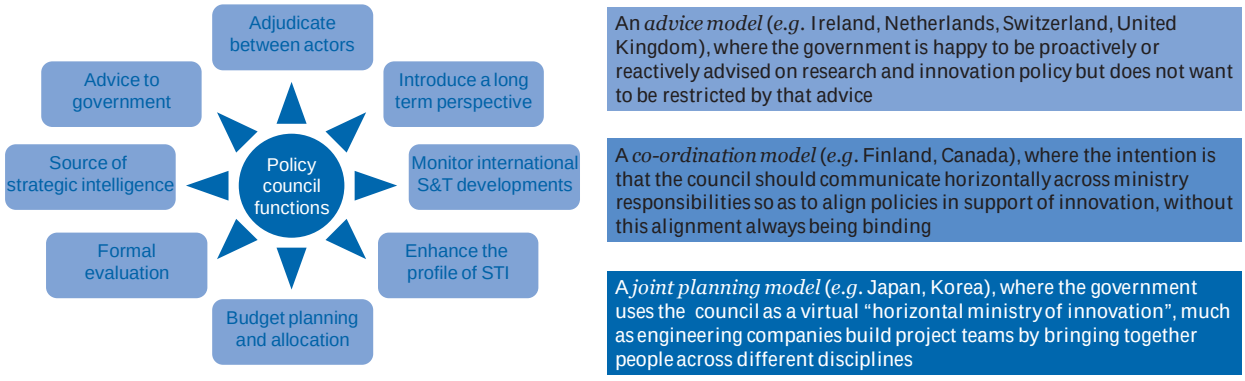
In the ministry set-up, the innovation agenda of the Ministry of Enterprise, Energy and Communications seems to be caught between two powerful forces: the Ministry of Finance's macroeconomic policies, which are not particularly attuned to structural policies in support of innovation; and the Ministry of Education and Research's higher education and science policies. The Ministry of Education and Research also has a formal co-ordination role within the government for all matters concerning research and innovation and is responsible for drafting the research and innovation bills. At least with regard to budget allocations, this situation also affects, and to a certain degree possibly somewhat sidelines, the formally

independent agencies like VINNOVA which sit on the less well-served side of the table. As already noted, the weakness of innovation policy in the Ministry of Enterprise, Energy and Communications does not seem to offer a helpful solution.

The aforementioned research and innovation bills provide a clear and secure planning horizon for all parties involved. On the one hand, they seem to have eased the still prevailing co-existence of a large number of government agencies in this policy field and may provide an incentive to come forward with inter-agency planning and co-operation. On the other hand, the bills seem to fortify the remaining parts of the sector approach: each ministry presents its policy agenda, its agencies and budget allocations for the following four years. This can lead to thinking in compartments and to a multitude of similar funding approaches and many forms of delivery.

Most OECD countries have a range of councils, commissions and committees that deal with aspects of STI policy co-ordination, and Sweden is no different. The role of policy councils is variable across countries, as Figure 4.1 shows. In Japan and Korea, they adopt a joint planning model, but in most countries they are confined to less ambitious co-ordination or advisory roles. Some councils are independent, others are composed of government representatives, and many are somewhere in between. Some are chaired by the head of state or a senior minister, many are not. Recent years have seen a growing number of councils dedicated to innovation policy in OECD countries. These sometimes extend the remit of existing S&T councils (*e.g.* Finland) but more often they are new structures (*e.g.* Australia) (OECD, 2012a).

Figure 4.1. Functions and types of high-level STI policy councils



Source: OECD (2012) *Science, Technology and Industry Outlook*.

A Research Policy Council has existed in Sweden since 1962, but its contemporary role appears to be limited to advising the Ministry of Education and Research on the preparation of the research and innovation bills every four years. An Innovation Policy Council, established in 2004, was chaired by the Minister of Enterprise, Energy and Communication. It was to provide a basis for communication between the minister and key innovation policy stakeholders, but it ceased functioning after a few short years. Consideration should be given to the (re)-establishment of an integrated Research and Innovation Policy Council, taking into account the variety of such arrangements in other countries and Sweden's specific institutional landscape. This recommendation requires as a prerequisite a higher ranking of innovation on the policy agenda in the Ministry of Enterprise, Energy and Communication.

The agency level

All in all, around 20 major agencies support research and innovation. This is a large number for a small country, and it is hard to find so crowded an organisational landscape in comparable countries, at least at the national level. This situation has an historical, political and factual basis. It is strongly linked to long-standing principles of policy making in Sweden, including consensus building by a broad elite, the high degree of agencies' operational independence and the small size of the ministries, and the continuing importance of sector policy approaches in higher education, defence, energy or environment. The wage earner foundations have added a further group of actors.

Box 4.3. Innovation policy concepts and their framing of policy interventions

The common understanding of research and innovation policy structure and challenges forms an important framework for policy discussions and programming. Sweden, like other Nordic countries, was an early adopter and developer of systems thinking and the notion of national innovation systems. The analysis here shows that a system (plus a systems perception) indeed exists; however, systems optimisation appears to be difficult. Authors such as Persson (2008) or Biegelbauer and Borras (2003) tend to be sceptical about full incorporation of the innovation paradigm in Sweden and see much stronger (and better integrated) innovation policies in Denmark, Finland or the Netherlands. In the same vein, Lundvall (2009), one of the founders of the innovation systems concept, sees Swedish public innovation policy as limited and narrow in scope and perspective compared to other Nordic countries. In particular, he finds a lack of proactive SME policies. Compared to Finland, Sweden changes agendas and settings less radically, while Denmark, a quick learner, has a broader and more pragmatic agenda. He criticises the focus on supply-side, academic and "hard" research initiatives and the undervaluing of softer innovation, demand-side measures and a more holistic view. According to Lundvall, Sweden's lead public actors follow less a systems-oriented approach and more a cluster and "triple-helix" inspired path.

The triple helix concept has been (and is) a strong source of inspiration for Swedish policy makers' innovation and regional policy. Following an influential paper by Etzkowitz and Leydesdorff (2000), it takes the original Swedish debate on the third mission of universities as a starting point. It postulates the importance of intertwining planning and action by the three strands of government, industry and university. Tri-lateral networks and hybrid organisations act as agents of change (p. 111). The concept has been developed for analysing multi-actor settings in dynamic surroundings, "an endless transition" (p. 113). This concept triggered policy debates, for example on the need for universities to adapt and engage in new activities. In practice, it inspired a number of policy interventions to link the three spheres more closely and to include all relevant parties in solving problems. At its best, the triple helix concept has inspired policy interventions and funding initiatives that mobilise regional and sectoral resources for a common good. At its worst, it has led to programmes with ill-defined goals, roles and instruments and has produced intermediaries that want to help all parties but have no clear mission to do so. Swedish policy examples show the potential of such triple helix approaches, but given the relatively small size of programmes there is sometimes the danger of "catch all, involve all" initiatives that are difficult to manage and to evaluate. The triple helix concept continues to pervade regional policy, particularly in Tillväxtverket (see section 4.9), but has been largely superseded by the EU's "knowledge triangle" concept in VINNOVA and the main innovation policy ministries.

Most of the organisations use projects within programmes as a main means of organising funding. Programmes small and large are often co-managed and co-sponsored by different agencies; for larger government umbrella initiatives, a multitude of agencies are entrusted with operationalisation and execution. This reflects in part the innovation system and "triple helix" conceptualisation that frames innovation policy interventions (Box 4.3). The Competence Centre and Excellence Centre programmes or the Institute Excellence Programme (Reeve *et al*., 2009) are examples of co-management of organisations such as VINNOVA, STEM or SSF, while the Eco-Innovation research initiative (Ministry of

Sustainable Development, 2006) can serve as a specific example of the umbrella approach. This initiative involves five agencies, all with an innovation agenda. In addition, FORMAS together with VR runs the Linnaeus Grants (Vetenskapsradet and Formas, 2010). FAS co-operates with Riksbanken and the Tax Office on a small tax research programme. VINN NU, another programme, aims at high-technology start-ups and deals with 20 cases a year (Bergman *et al*., 2010). Even in this case, part of the funding comes from a second partner, STEM, and the programme is very close to the business of both ALMI and Innovations-bron. Another notable example of this clustering of agencies is the Swedish Brain Power consortium, a comprehensive and recently terminated programme for research on neurodegenerative diseases such as Alzheimer's, Parkinson's or ALS with a budget of EUR 10 million over five years. The consortium included VINNOVA, the Vardal Foundation, Invest in Sweden, SSF, KKS and the Knut + Alice Wallenberg Foundation. The last of these continued its support after the programme ended in 2010 (VINNOVA, 2010, p. 7; Forskning.se, 2010, p. 17).

The consequences of this crowded landscape are varied. There are, of course, positive effects due to bottom-up planning or to the variety and resilience of the system. The overall picture, however, has worrying aspects, as the portfolios of funding actors show a considerable overlap. Given the many actors and their independence, there are too many, too similar and often too small interventions that rely on proven instruments or are too co-ordinated. If a lot of energy is expended on extensive horizontal interaction, there is probably less energy for vertical interaction; and if a multitude of agencies are all comparatively small or mid-sized, their power to advocate and shape a stronger and more integrated innovation policy tends to be weaker. The consensus instruments in place do not necessarily lead to the implementation of bigger and bolder ideas.

The situation of VINNOVA is important in this context. To the outer world – at least outside Sweden – VINNOVA is a synonym for technology and innovation funding in Sweden. On the one hand, the agency has been given (and continuously gives itself) very ambitious goals and claims to influence and change the innovation system. This review sees VINNOVA as a bold, risk-taking and central actor in the Swedish system which it seems to want to change and further develop. The agency is much more open and reflective about its goals and instruments and about the impact of its work than the dominant science policy actors. On the other hand, legacy commitments are very strong and budgets are limited. About half of the programmes VINNOVA is involved in are co-managed and co-financed with other agencies. This can undoubtedly be described as a strength and as a remarkable example of integrated policy making, but it also raises some concerns. Expectations of the agency do not match its resources and it is difficult to develop a strong individual profile. The problem is the crowded arena of actors, the weak position of innovation policy in Sweden and the lack of an appropriate budget for VINNOVA when compared to its aspirations.

In terms of recommendations, the government should seek to reduce the fragmentation of funding support. Collaboration between agencies on programmes (joint programming) is an effect of the organisational landscape which is difficult to reform and consolidate. Nevertheless, serious consideration should be given to consolidating the fragmented landscape of funding agencies and to creating a few powerful "innovation champions". This review is fully aware of the difficulties associated with such a proposal, as some of the players are independent semi-public foundations. But such proposals should at least be on the agenda. This should be accompanied by a better streamlining of the currently large set of funding programmes. Fewer larger programmes generally tend to be more effective. Finally the government should seriously consider

doubling the budget of VINNOVA over the next four to eight years, if its current ambitions for this agency are to be maintained. The alternative, to reduce this agency's ambitions, would be an unfortunate decision.

4.3.3. Policy learning through evaluation

Sweden has a strong record in evaluating programmes and other initiatives. The Nordic evaluation culture is often seen as a model for qualitative and formative ways of reviewing initiatives, and Swedish examples have over several decades strongly contributed to this positive image. A number of Swedish agencies and councils regularly have their programmes evaluated. In STI policy, the leading actor is VINNOVA (see Growth Analysis, 2011, p. 29, with a list of recent evaluations). It has an explicit strategy to detect the effects of funding that dates back at least to its predecessor NUTEK. These evaluations emphasise management, learning and procedures and often call on evaluators from abroad to conduct interim assessments of centres or programmes and their workings. For Swedish policy actors, incremental learning both on the programme level and on the level of the individual funded entity is seen as an important asset and these evaluations support learning processes. Typical examples include the numerous competence centre evaluations at different stages (*e.g.* Baras *et al*., 2000; Baras *et al*., 2003; Reeve *et al*., 2009; Reeve and Anderson, 2009), evaluations of the institute excellence centres and of VINNVÄXT, SME programmes and other VINNOVA programmes (*e.g.* Andersson *et al*., 2010; Märtensson *et al*., 2009; Stenius *et al*., 2008). When VINNOVA runs a programme together with other agencies, it often takes the lead in the evaluation process.

VR and other funding agencies and councils also list a number of programme evaluations on their websites. In the case of VR the list is somewhat less impressive, with a mix of centre programme evaluations, feedback activities regarding its own procedures or evaluative expertise on major Swedish research efforts or infrastructure issues. The "Forskningsfinansiering" report in 2008 as well as related documents criticise VR for not sufficiently using evaluation results: VR "has reduced the size of its analytical capability over time, and made little or no use of this capacity or of evaluation in setting policy" (Arnold, 2008, p. 2, quoting Sandström *et al*., 2008). Another council, FORMAS, has "developed a number of interesting strategy documents and conducted insightful evaluations, [but] it has had great difficulties in translating these into effective initiatives" (Arnold, 2008, p. 2, quoting Sandström *et al*., 2008). Like VR and VINNOVA, other agencies also make (some of) their evaluations open to the public, following the Swedish tradition of transparency.

In recent years, impact evaluations have joined more formative evaluations as a category of Swedish evaluation practice. However, in contrast to American approaches which are mainly quantitative, Swedish policy makers (essentially VINNOVA) want to better understand how things happen(ed) and place more trust in qualitative methods. This includes studies to understand single issue missions, such as the effects of neck injury research at a certain university or the impacts of funded projects on the use of IT in work organisation (Growth Analysis, 2011, p. 29), as well as longer-term effects. Recently VINNOVA has commissioned larger long-term impact evaluations, tracing activities and their effects back over twenty years or more (Arnold *et al*., 2008a; Arnold *et al*., 2008b). These studies can be qualified as a big step forward for understanding innovation policy. In the case of GSM, a clear picture emerges of when and where policy action has led to the build-up of trust, long-term relationships, room for experimentation

and the creation of academic strongholds through funding programmes, pre-standardisation activities, committees or explorative projects. Funded in turn by STU and later by NUTEK and VINNOVA programmes, policy action has led to research results useful for Ericsson and the main Swedish telecom provider (Televerket, later Telia) and staffed their R&D labs with trained researchers. Public action decisively contributed to the head start and ensuing huge success of Ericsson in digital switches and GSM infrastructures in the 1990s and early 2000s. Such longer-term studies reveal causal links and allow for a good analysis of public action that has made a difference.

The overall positive record can be contrasted with three critical issues:

- The policy level is lacking a systems evaluation which cannot be replaced by the common practices of open discussion and elite consensus. Potential downsides in the policy set up – strategies, vertical and horizontal governance, agency missions and interplay – are probably not transparent enough in current policy instruments such as discussion forums, strategy processes or preparation of research bills. In this context the functionality and roles of the various funding agencies could also be examined. More generally it could open entry points for vertical governance. Few efforts have been made to analyse (parts of) the governance level (Sandström *et al*., 2008), and they have not been very successful for various reasons. Austria and the Czech Republic (and indirectly Norway via the Research Council Norway evaluation) have undergone systems evaluations; they seldom lead to immediate overall changes but pave the way for more systems- and governance-oriented thinking. This can support a less ostentatious but more profound and detailed restructuring process.
- The picture for Sweden remains unclear when it comes to evaluations of public organisations, including universities. At least from the outside, this instrument appears either missing or difficult to access. This might relate to the strong position of Swedish universities. The first steps towards a performance-based financing system could lead to changes in this respect. Programme evaluations often say little about how public interventions affect organisational set-ups. This issue could be covered more prominently especially in light of the strong "systems" claim in Swedish research and innovation policy.
- While quantitative evaluations such as cost-benefit or impact analyses have to be used with care, Sweden could try some experimental quantitative evaluations, *e.g.* to learn more about the quantitative effects of various instruments that fund enterprises.

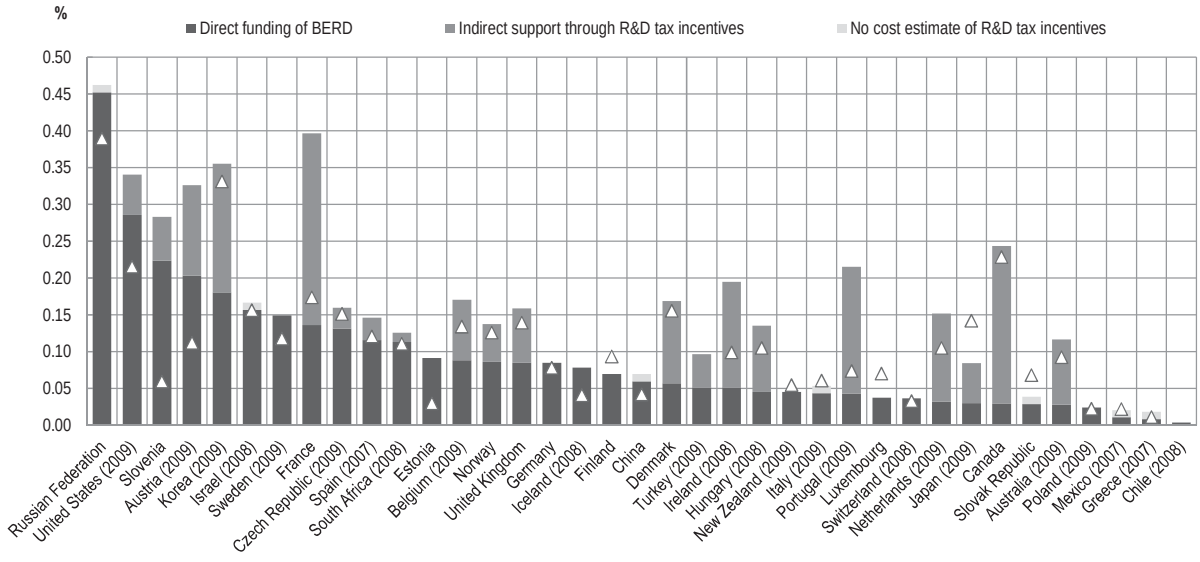
4.4. Supporting business R&D and innovation

Providing businesses with favourable framework conditions for innovation and fostering a conducive business environment are key tasks of governments today. Government can also do much to foster high-performing infrastructure, including in ICT, already one of Sweden's major assets. In addition, governments in all OECD countries take specific policy measures to support R&D and innovation in the business sector, though they do so in different ways.

As this report has shown, in Sweden as in other OECD countries public R&D funding is mainly directed to public research, which is overwhelmingly performed at universities. The situation is more nuanced for public support to business R&D and innovation. Sweden's direct government support to business R&D as a share of GDP

(0.15% in 2009) places it in the upper ranks of OECD countries, far behind the United States but also behind Korea and some small economies (Slovenia, Austria, Israel). However, Sweden spends more on direct public support per unit of GDP for BERD than its Nordic neighbours and all of the large European economies (Figure 4.2). Nonetheless, it makes rather modest use of direct public support for R&D when compared to the volume of Swedish BERD. The percentage of BERD financed by government is 5.9% for Sweden, below the OECD average of 8.9%.

Figure 4.2. Direct government funding of business R&D and tax incentives for R&D, 2010
As a percentage of GDP



Notes:

1. The estimates of R&D tax incentives do not cover sub-national R&D tax incentives.

2. Estonia, Finland, Germany, Luxembourg, Sweden and Switzerland do not provide R&D tax incentives.

3. The People's Republic of China, Greece, Israel, Italy, the Slovak Republic and the Russian Federation provide R&D tax incentives but cost estimates are not available.

4. Iceland introduced a tax reduction scheme for R&D in 2009 with effect from 2011.

5. Mexico and New Zealand repealed tax schemes in 2009. No cost estimates are available for Mexico before this date. In 2008, the cost for newly introduced R&D tax incentives for New Zealand was NZD 103 million (0.056% of GDP).

6. Data refer to 2004 instead of 2005 for Austria and Switzerland, 2006 for Poland, Portugal and South Africa, 2007 for Slovenia, 2008 for Belgium, Korea and New Zealand.

7. Estimates for Australia, Hungary and Korea are based on their responses to the 2010 OECD R&D tax incentives questionnaire.

8. The estimate for Austria covers the refundable research premium but excludes other R&D allowances. The value of the research premium has been taken out of direct government funding of business R&D to avoid double counting.

9. France implemented in 2008 a major upgrade of its R&D tax scheme which is now volume-based and has very high credit rates (up to 30%). In addition, from 2009 immediate repayment of unused credits are permanent for SMEs (before 2009, unused credits could not be refunded before three years). Foregone revenues for 2010 are estimated based on national sources.

10. Cost estimate of R&D tax incentives for Belgium are drawn from its responses to the *OECD Science, Technology and Industry Outlook 2012* policy questionnaire.

11. The United States' estimate covers the research tax credit but excludes the expensing of R&D.

Source: OECD, Main Science and Technology Indicators (MSTI) Database, June 2012; OECD R&D tax incentives questionnaires, January 2010 and July 2011; and national sources, based on OECD (2011), *OECD Science, Technology and Industry Scoreboard 2011*, OECD, Paris.

Moreover, Sweden is among the relatively few OECD countries, along with Finland, Germany and Switzerland, that did not follow the recent international trend towards offering R&D tax credits or other types of fiscal support for business R&D. When countries' direct support and foregone tax revenue associated with tax incentives for R&D are combined, Sweden spends a much smaller proportion of GDP on support for business R&D than France, Korea, the United States, Austria and Canada, but compares with Norway, Denmark, Belgium and the Netherlands.

EU funding provides an additional source of financial support for business R&D and innovation (see section 4.11). Industries such as telecommunications and car manufacturing have successfully used the Framework Programmes (FP) for precompetitive R&D and standardisation work. Large firms continue to participate in FPs in this way. The level of participation of SMEs is below the EU average but comparable to that of other leading small economies. Swedish industry participation in the FPs has declined over time. It could be higher for large and especially for small firms, but most advanced countries show a similar pattern. The stronger the players, the more an industry can profit strategically from the FPs (Arnold *et al*., 2008b).

The Swedish funding portfolio – its "policy mix" – is characterised by a rather small number of programmes targeting individual firms. As mentioned, Sweden is also among the few OECD countries that do not offer fiscal incentives for business R&D.[19] Instead, firms receive funding from a number of funding agencies and foundations, mostly as partners in consortia. Swedish innovation policy makers tend to ground their views in an innovation system approach and in concepts such as the "triple helix" (see Box 4.3). Most agencies and their programmes therefore rely on collaborative centres (to which firms contribute); regional consortia funded through VINNOVA, KKS, or Tillväxtverket programmes; and sectoral collaborative funding as in the sector programmes (Branschforskningsprogram, see Aström *et al*., 2012), again with firms as contributors.

VINNOVA is the most important funding agency for innovation and has a relatively broad portfolio of instruments to support firms. As noted above, a number of VINNOVA programmes and initiatives date back, in style and form, to NUTEK or even earlier. Overall less than 30% of the SEK 2 billion in annual funding goes directly to industry;[20] research institutes and universities together receive around 60% (VINNOVA, 2012, p. 14). The agency, often acting with other funding sources, operates a number of programmes which support industry directly or indirectly, including some truly high-profile initiatives with the following types of activities:

- VINNOVA has a strong record in funding sectorally targeted R&D in areas such as manufacturing, transport, health and ICT. It derives to some extent from the sector principle legacy described earlier but is also a feature of the research promotion portfolio in comparable countries. Its portfolio includes services sector innovation initiatives as well as funding for "ground-breaking" technology and innovations with a longer time horizon. Firms are partners in consortia.
- A more generic funding activity includes various types of programme under the heading "development of strong research and innovation milieus". These programmes, which include the VINN excellence centres, the Berzelii centres (funded jointly with VR), the Institute Excellence Centre programme, and the Industry Excellence Centres programme are described in section 4.8.
- VINNVÄXT supports regional growth and clustering in 12 growth areas across the country. This programme is described in section 4.9.

- Innovative SMEs is one of VINNOVA's strategic investment areas; about 500 of 1 900 projects funded in 2011 belonged to this segment (VINNOVA, 2012, p. 18). A number of programmes that focus on the firm level also focus on SMEs (VINNOVA, 2012, pp. 38-40). Research and Grow (Forska&Väx) was launched in 2006 with an annual budget of SEK 100-200 million; a main criterion for funding is a firm's ability to grow based on its R&D potential (Bergman et al., 2010, p. 33). The VINN NU programme tries to help high-tech start-ups develop their business and deals with around 40 cases a year. Most of these young firms come from the university sector (Bergman et al., 2010, p. 3 *ff.*). VINNOVA has also started a pilot project involving innovation vouchers to encourage SMEs to buy R&D services from universities, colleges or institutes. VINN Verification helps research-based enterprises with risk assessment (VINNOVA, 2010, p. 25) and other programmes target technology-oriented export efforts of innovative SMEs.
- In 2010 VINNOVA initiated a new strategy, Challenge-Driven Innovation. It received 628 applications at the first call (2011) and accepted 97. Currently the focus is on four social challenges: sustainable and attractive cities; health, well-being and medical care; competitive industry; and information society 3.0. In the ICT sector the agency runs a "ground-breaking research" programme with long-term research projects. "Co-creation", user needs and collaboration are the main characteristics of this multi-actor-initiative.

While Sweden's discipline concerning subsidies is commendable, it might consider increasing support for SMEs while trying to meet their needs in the most effective way. First, policy makers might consider improving availability of information on SMEs, their technological competencies, their needs as regards innovation and their position in value chains[21]. A second step might be to put more funds into initiatives like Research and Grow and broaden the use of innovation vouchers mentioned so that new small firms can get help in solving early problems from knowledge providers. A third step might be to consider support for industrial value chains at national or regional level without automatically using the triple helix model. A fourth step might be to consider tax incentives for innovation activities of smaller firms, but this would need to take account of the broader context.[22]

4.5. Facilitating access to risk financing

In facilitating their access to finance, the Swedish government aims to create good legal and institutional conditions for start-ups and SMEs. Sweden has also created some direct measures to facilitate enterprise finance. The main government organisations in this respect are Innovation Bridge (Innovationsbron), Almi Business Partner Ltd. (Almi Företagspartner AB), and the Industrial Development Fund (Industrifonden). These organisations are briefly presented in Box 4.4.

Box 4.4. Main government organisations facilitating access to risk finance

Innovation Bridge[1] is a state-owned limited company that helps to commercialise ideas from universities and business. It has seven regional offices and five subsidiaries. In the Budget Bill for 2012 Innovation Bridge received SEK 135 million. Supported projects should include high levels of new and advanced technology. Enterprises can be assisted through incubators, advice and financing. Seed funding activities involve collaboration with other private and public investors at local, regional and national level. The services offered include:

- *Seed funding*: FOKUS Verifiering is a development grant through which Innovation Bridge, with VINNOVA, offers funding for commercial and technical verification and intellectual property protection.
- *Soft loans*: loans without security of up to SEK 500 000 can be issued for early technical and business development work.
- *Equity*: Equity investments are made directly, through three investment subsidiaries, and indirectly through other financing organisations. There is no required overall rate of return on these investments, other than to preserve the original capital. Private co-investment also occurs.
- *Incubators:* A national incubator programme helps participating incubators to increase the flow of business ideas. The programme also includes a development process for company and business development, as well as activities for benchmarking and exchange of experience between incubators at national and regional level.

Almi Business Partner Ltd.[2] is a non-profit public company headquartered in Stockholm with 21 regional offices (these are subsidiaries 51% owned by the Swedish state and 49% owned by regional public authorities). Almi offers a combination of advice, business development services and supplementary financing. Almi is the main publicly supported SME lending facility. The target groups for Almi's lending are new, growing and innovative enterprises, although loan disbursement overall is said to follow a low-risk strategy. Almi also offers micro loans and export financing. Almi and the Innovation Bridge work closely together and in some cases have a common application procedure. Almi's lending activity is self-financed. Some 2 000 firms receive financial support each year.

The *Industrial Development Fund*[3] is an independent foundation formed by the Swedish government in 1979, whose role is to promote profitable industrial growth in Sweden. The Fund has assets under management of around SEK 3 000 million. The Fund invests in equity but can also provide loans. It can purchase equity via placements or rights issues and owns shares in several venture capital companies in Sweden (it is a shareholder in Innovation Bridge). The Fund mainly focuses on companies with growth potential, supplying early-stage and expansion capital. All investments are made on a commercial basis in co-operation with entrepreneurs and other investors (including Swedish and international business angels, and public institutions). Investments focus on ICT, the life sciences, industry (automation, material technologies, manufacturing and services). Amounts typically range from SEK 5 million to SEK 165 million. The Fund currently has direct investments in about 100 companies throughout Sweden.

1. For more information see *www.innovationsbron.se.*
2. For more information see *www.almi.se.*
3. For more information see *www.industrifonden.se*.

In addition, two relatively new venture funds aim to supply equity to firms in a remote northern region of Sweden and to the automotive sector, respectively. In December 2010 the government established a venture capital fund for northern Sweden, Inlandsinnovation, with an initial capitalisation equivalent to some SEK 2 billion. The fund for the auto sector, Fouriertransform AB (FTAB), a state-owned venture capital company established in December 2008, has a capitalisation of around SEK 3 billion. FTAB was founded to strengthen the Swedish automotive industry, especially with respect to safety and environmentally friendly technologies. FTAB is perhaps the only exclusively automotive-focused private equity firm in Europe (Blom, 2011). To June

2011 FTAB was reported to have made investments in eleven companies, for a total of some SEK 398 million (just 13% of the initial capital).

Regional venture capital funds also operate. These receive European Regional Development Fund (ERDF) support and regional co-financing. The ERDF initiative formally began in 2009. Tillväxtverket (2011) provides a mid-term evaluation of the activities supported by the ERDF. The report suggests that at least some of the regional funds might not be in a position to invest their entire capital base before the ERDF-supported project ends, although other funds report excess demand from interested companies. The report notes that while it is difficult to assess whether the supply of equity capital has improved as a consequence of the initiative, there is some (interview-based) evidence of programme additionality in that just over 20% of the evaluated companies stated that there was no alternative source for the funding they received. A further 25% of the evaluated firms asserted that while alternative sources of funding were available, they did not offer equivalent terms. Some of these regional venture capital funds may be operating at sub–critical scale, as is the case for sub-national venture funds in many countries.

It is beyond the scope of this review to undertake a detailed assessment of the different financial instruments and organisations described above, though a few general observations can be made. On first inspection, certain aspects of the modus operandi of the Inlandsinnovation and Fouriertransform AB funds do not appear to accord with global best practice. Publicly owned and managed venture funds have had a consistently poor track record across OECD member and non-member countries (Box 4.5). The commercial logic behind the creation of the funds may also be questionable (given, for instance, that there will inevitably be few promising new ventures in the remote northern region). While there is often a temptation to orient government-supported risk-finance instruments to address social objectives, a commercial orientation in investment decision making often leads to better developmental and employment-generation outcomes.[23]

Box 4.5. Publicly financed venture funds – performance and stylised facts

Early efforts to support the development of venture capital often focused on the creation of government-funded schemes. However, publicly funded schemes have encountered a recurring set of problems (Leleux and Surlemont, 2003):

- The managers of public funds are often civil servants. As such, they may lack the experience and skills required to successfully select and support investee firms.
- Incentive systems in publicly owned funds may fail to attract suitably skilled venture fund managers. They may also fail to encourage good performance in ways that private venture funds would, for instance through performance-linked bonuses.
- Public funds may displace private funds. This is especially likely if public schemes finance projects at below-market rates. Displacement is not only financial: public investment expertise will also displace private expertise, which is likely to be more skilled. There is evidence both for and against the proposition that public funds “crowd out” private funds. At the least, this suggests that the Hippocratic injunction to “do no harm” should inform policy development.
- If public funds forego commercial objectives, so as to meet other policy goals, the ability to attract private investments and professional fund managers might be limited. In such cases, the sustainability of the programme will be in jeopardy.

Observers have noted that only a relatively small portion of overall public support for equity investment in Sweden targets the seed stage. Svensson (2011) estimates this share to be around 16% of all government support, and points out that the seed stage presents the lowest risk of government crowding out private financing. This study observes that the board of many public funds (on which the government is represented) requires funds not to make losses. As a consequence, the funds seek projects with low risk, *i.e.* projects in late phases. Examination may be needed of the appropriateness of the balance between support for seed and later-stage financing.

In many countries, a preferred model of support for equity finance involves allocating public support through either "hybrid" venture capital programmes or through a so-called "fund of funds". There is currently no publicly financed pure fund-of-funds arrangement in Sweden, although some government-supported initiatives invest in firms and in other funds. These include Innovation Bridge Ltd., the Industrial Development Fund, the Norrland Fund and the Sixth AP Fund (which invests public pensions). Under a fund-of-funds approach, government provides financial resources to a quasi-governmental body, which then invests these as a limited partner in privately managed venture capital funds. Advantages of information and expertise are obtained by letting successful private venture funds make investment decisions. The private venture fund can raise capital from both international and national investors, as well as the Swedish government, which would in this way become a co-investor in the portfolio companies. An example of such a fund of funds is the recently created United Kingdom Innovation Investment Fund.[24] Tillväxverket (2012) suggests that there is interest among private players and regional stakeholders in participating as investors in the formation of funds of funds.

Furthermore, Svensson (2011) notes that some funds do not have any requirement of co-financing by private investors. Consequently, a lack of market signals about promising projects results in a failure to mobilise private venture capital.. In this respect, increased co-ordination of Swedish funds could be beneficial. The need for improved steering, co-ordination and impact assessment of publicly supported venture capital activities is also highlighted in a recent report by McKinsey & Company (2011).

The government has stated its intention to restructure the publicly owned venture capital organisations. Drawbacks associated with the existing financing instruments, and discussion of possible alternative arrangements, have been the subject of a number of recent assessments (*e.g.* McKinsey & Company, 2011; Tillväxverket, 2012). A current legislative proposal includes the establishment of a joint organisation, including the venture finance operations of Almi and Innovation Bridge. A proposal for the co-ordination of initiatives to supply venture capital will be included in the 2013 Budget Bill (Prime Minister's Office, 2012).

In recent years the government has taken steps to support business angel investments. These measures are however small in scale. Tillväxtverket has allocated a total sum of approximately SEK 5.5 million to seven pilot projects that are set to run for around two years. In 2010 it also decided to support women business angels, through projects with resources of about SEK 5 million. Some 12 seed funds also operate with the participation of business angels. Most of these are linked to business incubators operating under the umbrella of the Swedish Incubators & Science Parks association (see Chapter 3). These are not direct government initiatives, although some incubators receive public funding.

Much of the focus of policy support for early-stage equity financing in Sweden is on expansion of the supply of funds. However, an array of demand-side considerations is also important in determining the level of venture investment. More attention to these

demand-side considerations might be required, notably to improve investment readiness among Swedish start-ups, and possibly to improve knowledge of intellectual property (IP) issues among entrepreneurs (however, business incubators do play a role in developing investment readiness). A focus on demand-side conditions also makes sense given the small size of the Swedish market for risk capital.

The underlying rationale for a focus on demand-side considerations is as follows. There is considerable evidence that innovative business activity occurs prior to the development of venture capital (*e.g.* Hirukawa and Ueda, 2003; Zucker *et al*., 1998). Demand factors can also constrain firms' adoption of optimal financial structures. Among entrepreneurs, knowledge of external equity investment processes is sometimes limited. Furthermore, venture capitalists often demand a significant equity stake in the investee firm, as well as board participation, while entrepreneurs are often averse to surrendering even a minimal degree of control over the enterprise. Consequently, many businesses are under-capitalised. This adds to their risk, which can in turn deter providers of debt. A greater willingness to accept external equity would facilitate growth and survival in many small firms. Furthermore, it is frequently observed that a lack of good projects can constrain the expansion of venture capital activity. In practice, most investment proposals put to venture capital funds are rejected. There is also evidence from Canada and the United Kingdom that a large fraction of investment proposals put to business angels are rejected because of quality concerns. Consequently, policies that help to improve the quality and presentation of investment projects – their "investment readiness" – might expand access to equity finance (Box 4.6).

Box 4.6. Programmes to enhance investment readiness: Some stylised findings

Investment readiness has been defined as "the capacity of an SME or entrepreneur – who is looking for external finance, in particular equity finance – to understand the specific needs of an investor and to be able to respond to these needs by providing an appropriate structure and relevant information, by being credible and by creating confidence" (European Commission, 2006).

Investment-readiness programmes can help new and fast-growth firms in a number of areas. They can assist, for example, in developing a business plan, explaining the sources of financing, understanding investors' requirements, ensuring that the right management skills are available, and improving the quality of presentations made to investors. Appropriate education, training and information might also help to reduce aversion to external equity among entrepreneurs. A number of observations can be made about the design and operation of investment-readiness schemes:

- Different models exist. Some schemes are publicly sponsored, as in Ireland and Spain. Others are privately run, as in France and Austria. In the United Kingdom, public and private programmes operate. It is unclear whether a particular model is best.
- Many sources of advice might be used, from retired entrepreneurs – as in Ireland – to recent business school graduates – as in France. However, a generic insight from the literature on business development services is that the greatest value is typically attached to advice from others with business experience.
- Many schemes exclusively target young firms (Toschi and Murray, 2009). This focus could be enlarged, because fast-growth firms can also be relatively old. Indeed, as fast growth may be somewhat unpredictable, it is important not to use overly rigid eligibility criteria that could exclude potential beneficiaries.
- Among the services offered, attention should also be given to the management and use of intellectual property, as a source of competitiveness and as a means to raising finance.
- Broader business development advice, while often provided by different types of programme, is also relevant to investment readiness. The integration of such advice should be sought (Toschi and Murray, 2009).
- Better evaluation would be valuable. Evaluations of the effectiveness and efficiency of investment-readiness programmes are scarce. In fact, it was not possible to find evaluations that used real-world or statistically constructed control groups.

4.6. Nurturing skills for innovation

Given the apparent decline in Sweden's educational standards, as exemplified by declining PISA scores, the government has set out and begun to implement a series of reforms of the educational system. Six challenges were identified in the 2009 Budget Bill. These relate to: increasing the attractiveness of a teaching career; improving compulsory school results; improving school learning environments; increasing the number of young people interested in mathematics, technology and science; increasing the number of students finishing upper secondary school with good results; and better exploiting the potential of pre-school.[25] In implementing reforms, the focus has so far been on the early school years, although it is recognised that higher education also needs to be strengthened (Prime Minister's Office, 2012). To improve education in mathematics, science and technology, the government introduced a trial programme focused on technology in upper secondary schools in 2011. Beginning in 2013, SEK 100 million will be provided for a three-year period to assist students in natural sciences and technology programmes to undertake internships in the technology sector.

As well as nurturing home-grown talent, OECD governments have introduced a variety of initiatives to attract highly qualified people from abroad. One government measure to make Sweden more attractive to highly qualified people was the 2001 introduction of tax benefits for foreign experts, executives, scientists and researchers. This tax reduction allows eligible foreign nationals to pay tax on only 75% of their income during their first three years in Sweden. In 2012, the tax exemption for foreign experts and highly qualified competencies was modified to exempt all foreign experts from certain parts of the income tax when their remuneration surpasses a certain threshold. More could be done to attract and retain top international talent and the potential role of foreign-born graduates and researchers in starting up business firms does not seem to have received the attention it deserves. The introduction of tuition fees for non-EEA students may be counterproductive from this perspective.

Although Sweden compares favourably on the gender distribution of researchers, a better balance is needed on senior positions. VINNOVA has funded the VINNMER programme since 2007; its strategic objective is to help increase the number of post-graduates who subsequently become future leaders at universities/colleges, centres, research institutes and companies. The programme is directed towards the under-represented gender in the relevant scientific field and towards researchers with a PhD who have completed their post-doctoral training. An important criterion is that researchers should conduct needs-driven research in co-operation between a university/college and operations in the private/public sector. The total budget, including co-funding, is just over SEK 600 million.

Another relevant issue is the availability of work placement opportunities in SMEs for graduates with science and technology degrees. Many graduates are reluctant to work in SMEs, as employment in large firms is often associated with superior remuneration, conditions of work and prestige. At the same time, some small firms are biased against recruiting graduates, wrongly judging that they have inappropriate experience. Given that graduates can be a source of new ideas and skills, this labour market mismatch has a bearing on the development of small firms. It also has a bearing on entrepreneurship, as employees in small firms frequently aspire to become owners of small firms themselves. An employee placement scheme for graduates targeted at small firms might help to reduce this mismatch. Most of VINNOVA's initiatives in this area target postgraduate mobility, but it is unclear whether these programmes have sufficient scale to make a

significant difference at the national level. The government should therefore consider whether there is adequate development of employee placement schemes for graduates targeted at small and high-tech firms.

Entrepreneurship education

Sweden has done much to encourage entrepreneurship in ways likely to enhance social perceptions of this vocation. In 2009 a "Strategy for entrepreneurship in the field of education" was published by the Ministry of Education and Research and the Ministry of Enterprise, Energy and Communications. The document makes clear that the government considers the teaching of entrepreneurship to be essential throughout the education system.

The Junior Achievement Company Programme (JACP) is a nationwide entrepreneurship education initiative at the secondary level which aims to improve practical understanding of how to start and run a company. Internationally, entrepreneurship education programmes are underevaluated, especially outside of the United States. Too little assessment takes account of selection effects (in particular the tendency of students with a prior interest in business to choose to follow courses on entrepreneurship). However, Elert *et al*. (2012) have analysed the effects of participation in the JACP, comparing firms created by JACP alumni with a matched sample of firms in the same industry created by individuals of the same age, gender and education. The study shows that the probability of creating a firm, and of survival and job creation by the firms created, is greater among JACP alumni. These effects are particularly pronounced for women.

Box 4.7. Stockholm School of Entrepreneurship

The Stockholm School of Entrepreneurship (SSES) was founded by the Royal Institute of Technology (KTH), the Stockholm School of Economics (SSE) and Karolinska Institutet to develop an integrated teaching curriculum to meet the demands of students, faculty and industry. A generous donation from the Erling-Persson Family Foundation allowed the school to establish itself firmly as an independent organisation in August 1999. This was followed by a further donation from the foundation in 2002, which made it possible for Konstfack to become the fourth member institution. In 2009 Stockholm University was invited to join as the fifth member institution.

SSES is recognised as a leading academic facility in the area of innovation and entrepreneurship. Its origin can be traced back to several courses taught at KTH and SSE in the 1990s. Its mission is to increase interest in and knowledge about practical and interdisciplinary entrepreneurship throughout the SSES's member schools. It was established to provide member schools' students with inspiration, education and training in applied entrepreneurship. As interest grew, so did the need to recognise how important entrepreneurship is in a modern economy, and to structure the teaching of relevant skills accordingly. The school draws on the different academic environments of its five member institutions and gathers their innovative and entrepreneurial competencies under one roof in a joint education programme. This academic programme in practical entrepreneurship education and training has already offered over 130 academic courses, over 185 extracurricular activities, examined over 7 000 students and led to over 350 companies operated by alumni students. It works as a brand, an operating platform for marketing, management and co-ordination as well as an international network of entrepreneurs and researchers.

SSES is structured as a non-profit association with the acting rectors of the member universities as eligible members. The board of SSES represents the member universities and industry representatives. This structure creates strong regional and personal commitment to SSES. It also provides a sustainable and effective platform for high-level academic decision-making. SSES is also represented by a dedicated team of some 60 faculty and staff. Around 200 guest speakers, mentors and coaches take part in the education programme every year.

Government agencies such as NyFöretagCentrum coach young entrepreneurs and support entrepreneurship through seminars, exhibitions and conferences. One example is an annual exhibition, Eget Företag, which brings together, over several days, young entrepreneurs, IT start-ups, web-development service providers, coaching companies, representatives of government agencies and others. Start-up contests such as Venture Cup are also held. Universities have also added new programmes related to entrepreneurship. For instance, the Stockholm School of Entrepreneurship (SSES) is operated by five universities in Stockholm to offer entrepreneurship tuition for Swedish and international students, as well as workshops, conferences and networking events (Box 4.7).

4.7. Spurring demand for innovation

Over the last decade or so, it has become increasingly fashionable to call for greater attention to the demand side, which has been largely neglected in OECD countries. The growing interest in demand-side policies reflects in part greater awareness of the importance of feedback linkages between supply and demand in the innovation process. Interest in demand-side policies also reflects a frequent perception that traditional supply-side policies have not succeeded in bringing about desired improvements in innovation performance. Furthermore, pressures on governments' discretionary spending also create incentives to explore how innovation might be fostered without engaging in new programme spending. Innovation-oriented procurement holds a particular attraction, to the extent that policy makers judge that innovation might be increased by altering features of public spending that would have occurred anyway.

4.7.1. Innovation-oriented procurement

Along with many OECD governments, the European Commission[26] and the People's Republic of China, Swedish authorities now see public procurement as a possible demand-side tool for stimulating innovation. There are a number of reasons for this:

- Because of their purchasing power, governments can shape innovation directly and indirectly. Firms can benefit if procurement helps them recuperate the sunk costs of large and sometimes risky investments.
- By creating a signalling effect as lead user, governments can also influence the diffusion of innovations. Indeed, a number of major technological innovations, including Internet Protocol technology and the Global Positioning System, have their origin in public procurement. Public procurement has also been a determinant of the emergence of a number of high-technology sectors in the United States, Japan and France (where public procurement has been used, for instance, to develop high-speed rail technology and to ensure a competitive advantage in nuclear energy technologies).
- The delivery of essential public services can be more cost-effective if innovation targeted to those services is successful.
- Public-sector demand may help counter problems of access to finance for small firms.
- The possibility of inducing innovation via procurement outlays that would have occurred anyway is particularly attractive in a context of fiscal constraints.

- Governments may need to create a market for new technologies in order to meet policy challenges that are time-bound (such as meeting agreed reductions in levels of CO_2 emissions).

Historically, public procurement has played a significant role in the development of a number of Sweden's largest and most innovative companies. Since Sweden's accession to the European Union, and with it the requirement to abide by Europe-wide Public Procurement Directives and Treaty Principles, the scope for continuing historically strategic alliances between business and the public sector, cemented through procurement, has been reduced. Nevertheless, a number of initiatives are under way in Sweden to promote innovation-oriented procurement. To date, they largely constitute forms of preparatory work, more than implementation and evaluation. Among the initiatives in question are the following:

- Three public inquiries related to public procurement and innovation that have either been or will shortly be completed. They include the Ministry of Enterprise, Energy and Communications' *Public Procurement for Innovation*; the Ministry of Health and Social Affairs' *Organisation of State Support for Public Procurement*; and work by the Public Procurement Committee of the Ministry of Health and Social Affairs to assess procurement rules from an economic and social policy perspective, including an innovation perspective. In addition, VINNOVA prepared a procurement programme outline in May 2011. These documents variously hold that:
  - the public procurement of innovation can deliver significant innovation effects in the public sector and in private industry;
  - currently, very little innovation procurement takes place and significant potential remains, particularly in the areas of infrastructure, health and the environment;
  - improved information and guidance are required for procurement bodies; and
  - current legislation, while it does not prevent innovation-oriented procurement, does entail some restrictions.
- The *Public Procurement for Innovation* inquiry proposes the introduction of a new law on pre-commercial procurement that will facilitate multi-stage competitive procurement and the creation of a national database for pre-commercial procurement. As Sweden does not have a national innovation procurement policy in the health sector, the Inquiry also proposes the creation of a special commission to develop institutional conditions supportive of innovation-oriented procurement. Forward commitment procurement – whereby authorities advertise intentions for future procurement contracts – is considered a positive approach to follow.
- VINNOVA has worked to develop innovation-oriented procurement since 2006, mainly through policy but also through pilot work. Between 2009 and 2010, it undertook a number of pilot activities. These focus largely on the phases preparatory to procurement. None of these has yet led to actual procurement, nor do they constitute pre-commercial procurement. However, in a tender opened in May 2011, a follow-up project was submitted from one of the pilots. This follow-up project addresses procurement of innovative solutions for providing meals for the elderly.

- VINNOVA is also participating in pre-commercial procurement funded through the 2011-2012 FP7 Work Programme for ICT. It addresses robotics solutions for healthy ageing. The project involves an international consortium of nine partners, including the City of Västerås, along with bodies from the United Kingdom, the Netherlands, Denmark and Finland. The project, called SILVER, commenced at the start of 2012, runs for 45 months and has a budget of almost SEK 40 million.
- A variety of other Swedish institutes have had roles in connection with innovation and procurement. These include the Swedish Council for renewal and innovation in public administration; the Swedish Environmental Management Council (SEMCo) in providing support for environmental and other sustainable procurements; and several regional and local authorities such as the Skåne region and the City of Västerås. A regional network has also been established for innovation-oriented procurement learning and information.
- In the Budget Bill for 2012, VINNOVA was granted SEK 24 million to develop and operate a competency and support initiative for innovation procurement aimed at contracting authorities and innovative companies. At first the initiative will include: preparation of concepts for innovation procurement (*e.g.* pre-commercial procurement), including grants; the development of templates, guidelines and a help desk function, including legal advice; information dissemination (website, tours, lectures, printed materials, etc.); and collaboration with other agencies and organisations, both nationally and internationally.
- Recent changes in procurement legislation also open the way to the creation of central purchasing bodies and the use of competitive dialogue in procurement, both of which can be useful in fostering innovation through procurement. A potentially larger market resulting from centralised procurement allows companies to defray the fixed costs of innovation more easily, while competitive dialogue can facilitate information flows between procurers and vendors that are useful in the development and purchase of novel products and services.
- The Swedish Energy Agency has worked since the early 1990s to promote technology procurement aimed at supporting the development and diffusion of energy-efficient products. These efforts are reported to focus on incremental innovation.

There are a number of generic challenges for developing innovation-oriented procurement (Box 4.8). Among other things, meeting these challenges may require the development of expertise and the integration of new competencies across parts of the public administration that may not work together frequently. Procurement processes will also need to engage users in new ways. Given the strength of its public administration, Sweden's experience in moving forward on innovation procurement as it develops will also provide lessons for others.

Box 4.8. Generic challenges to innovation oriented procurement

The concept of fostering innovation through procurement is not new and some countries have pursued active technology procurement policies for decades, particularly in defence, energy and transport. Nevertheless, evaluative evidence on different practices is scarce, and in some fields, such as health, international experience is limited. VINNOVA's 2009 publication "Can Public Procurement Spur Innovations in Health Care?" is one of the few studies to examine innovation-oriented procurement in the health sector systematically. A number of OECD governments have recently given renewed impetus to using procurement to foster innovation. For instance, the United Kingdom has actively sought to integrate innovation procurement across government since 2003. Germany has created a new Agreement on Public Procurement of Innovation according to which six federal ministries (interior, economics, defence, transport, environment and research) will publish long-run demand forecasts, engage in continuous market analysis to identify potential new solutions, offer professional training on legal options to promote innovation, and foster a strategic dialogue and exchange of experience among procuring agencies, end users and industry.

General government procurement can be organised so as to be more conducive to innovation by incorporating requirements for incremental innovations in purchased goods and services in tender specifications and assessments. However, "innovation-friendly procurement" is still primarily concerned with cost-effectiveness in the purchase of more or less off-the-shelf items. Yet public procurement can also be used to create demand for technologies or services that do not exist. The design of such pre-commercial procurement, as with traditional procurement, must avoid the risk of capture by vendors and/or other anti-competitive effects. This challenge will likely be more acute for pre-commercial procurement, as some interaction with suppliers of not-yet-existing products may be needed in formulating tenders that are technically feasible.

An additional challenge is that procurement may be fragmented across local, regional and national public agencies. Indeed, in many countries sub-national units of government play important roles in the public procurement market. This means having the requisite expertise available across many procurement bodies. Particular skills may be needed, for instance, to evaluate bids for innovative solutions against qualitative award criteria. A relevant experience here is the Gateway Review undertaken by the United Kingdom's Office of Government Commerce. For acquisition programmes and procurement projects in central government, the Gateway Review allows experienced independent practitioners to examine projects at critical stages in the lifecycle. A decentralised procurement system may also lack the scale efficiency and risk-mitigation possibilities available to more centralised systems.

Furthermore, many agencies with responsibilities for public procurement operate separately from government agencies tasked with fostering innovation. Specialised procurement agencies are mainly responsible for efficient purchasing, and may lack expertise in the relevant fields of innovation. Procurement of innovation also entails risks beyond those entailed by traditional procurement. These include:

- Technological risk, *i.e.* risk of non-completion owing to technical features of the procured good or service. One mitigation option is contract design, for instance using cost-reimbursement contracts. As part of the bid submission, vendors might also be asked to analyse risks associated with their proposals and assess how these could best be managed.
- Risks related to uptake by users of the good or service. These might stem from such issues as inadequate absorptive capacities in procuring institutions or incompatibilities with existing technologies or routines. Such risks can be mitigated through early user involvement in the procurement process, for instance through structured consultations and foresight exercises. Outside of specific procurements, VINNOVA is already doing some work along these lines indirectly. For example, its Innovation Gates project (Innovationsslussar) seeks to make use of good ideas from people working in the health-care sector by supporting the translation of these ideas into commercial products and services; its work on e-government also starts from the identification of users' needs, with the aim of increasing capacity, efficiency and productivity in the public sector.
- Market risks exist on the side of both supply and demand. On the demand side, risks are greatest for wholly novel items. Public bodies may mitigate risks by implementing additional demand-side measures, such as user training schemes, or by using demand aggregation, in particular by bundling public demand. On the supply side, the main risk is that suppliers may not respond to the tender. To mitigate this risk, market intelligence capacities should exist, developed for instance through structured exchanges with industry experts. However, any information provided by public bodies during such exchanges would also need to be made available to all potential vendors to ensure conditions of competitive tender, perhaps on online procurement portals. Governments may also need to create confidentiality agreements with vendors who reveal technical information during a consultation. Financial incentives can also be offered for participation in pre-commercial tenders, to offset the research or development costs incurred by firms.

4.7.2. Public procurement of R&D: small business innovation research-type programmes

Aside from public procurement of innovation, a number of countries operate programmes to purchase research and development services strategically from SMEs. In this connection, the Small Business Innovation Research (SBIR) programme was introduced in the United States in 1982 (Box 4.9). The perceived success of the programme has inspired similar initiatives in other OECD countries, notably Japan, Australia, the United Kingdom and the Netherlands. Various Swedish counterparts consider that Sweden might benefit from such a scheme.

Innovative small firms often face difficulties for attracting investors to support their innovation projects, especially at the seed stage. So, from a government perspective, SBIR-type programmes might include sources of ideas (*e.g.* financially constrained SMEs) that would otherwise be omitted from procurement efforts. Indeed, there is some evidence from the United Kingdom that an SBIR-equivalent programme has had a role in attracting private third-party funding to awardee firms. In the United States, award recipients retain the rights to intellectual property developed using the SBIR award, with no royalties owed to the government. The government retains the right to royalty-free use for a period but rarely exercises it. Allowing recipients to retain rights to resulting intellectual property can make such contractual arrangements attractive to firms.

Box 4.9. The Small Business Innovation Research (SBIR) programme in the United States

SBIR requires government agencies (mainly the Department of Defense, the National Institutes of Health, NASA, the National Science Foundation and the Department of Energy) to allocate 2.5% of their R&D budgets to the programme. The SBIR offers competition-based awards to small innovative firms in three phases.

- Phase 1 (six months): USD 100 000 for a feasibility study to allow small firms to test the scientific and technical feasibility of an R&D effort.
- Phase 2 (two years): USD 750 000 for a full R&D effort.
- Phase 3: the firm pursues the commercialisation objectives resulting from Phases 1 and 2 with non-SBIR funds. Phase 3 follow-on projects can benefit from US government R&D funding but awards are funded from mainstream budget lines.

The SBIR programme is worth over USD 2 billion and makes over 4 000 awards annually. SBIR funds support public procurement because awards are ultimately linked to meeting public-sector needs. Details of the topic and the awardee are published on the Internet, and most award winners have fewer than 25 employees. Some evaluative work has shown that SBIR funding has led to increased growth and employment creation and a greater likelihood of attracting venture financing (Lerner, 1999; NRC, 2000), although other analyses have cast doubt on the additionality of SBIR impacts (Wallsten, 2000).

Such programmes can help to tap a larger pool of innovative ideas, drawing in SMEs that might not otherwise take part. There is also evidence that these schemes can help SMEs secure third-party financing. While there may be an opportunity for greater application of this kind of policy tool to promote innovation in Swedish SMEs, the design risks associated with such programmes should be recognised. The key concern may be that government funds might simply crowd out privately financed R&D. To avoid this, weighting should be employed in targeting candidate/recipient firms so that additionality is likely to be high. The monitoring of programme managers' performance should be tailored accordingly. SBIR-type initiatives tend to develop a technology to a certain level of readiness, while major commercial success is likely to require substantial subsequent funding.

4.8. Fostering excellence, relevance and critical mass in public-sector research

Chapter 3 has highlighted the significant resources dedicated to university research. These have grown markedly since the 2008 Research and Innovation Bill and have been further boosted in the new 2012 Bill. At the same time, the government has encouraged universities to prioritise their research fields through strategic profiling exercises. This is part of a drive towards excellence and critical mass. Universities are also being encouraged to pay greater attention to the commercial exploitation of the research they perform, *e.g.* through a programme of new innovation offices (Box 4.10).

Box 4.10. Innovation offices programme

The 2008 Research and Innovation Bill included the launch of "innovation offices" (*innovationskontor*) to facilitate the (commercial) utilisation of research results from universities. Their purpose is to support researchers and university management with a number of services, including innovation advice, business development, verification, management of intellectual assets, and awareness raising. In a first round, eight innovation offices linking a total of 11 Swedish universities were founded. A recent government review of innovation-stimulating activities at universities[1] stresses the importance of innovation offices in increasing universities' ability to act innovatively. Accordingly, the new 2012 Research and Innovation Bill has increased the allocation of funding to innovation offices and announced the establishment of a further four offices to extend the scheme's reach to cover all universities.

1. "*Innovationsstödjande verksamheter vid universitet och högskolor - en preliminär delrapport*", SOU 2012:40.

Many innovation policy instruments are channelled through academic-led consortia, and universities host most of the (many) centres funded by the many centre programmes (see below). Whether or not this is seen as a desirable feature, Sweden has no large individual research strongholds of the size of a Max Planck institute. Sweden's top research remains on the mid-size level. A larger infrastructure-based initiative like the MaxLab in Lund has been described as the result of a series of fortunate occurrences, specifically supported neither by university leadership nor by state planning authorities (Hallonsten and Benner, 2009, pp. 65 *ff.*). Recent policy in support of large research infrastructure projects (Box 4.11) seeks to change this.

Box 4.11. Large research infrastructures

Large investment projects driven by the public sector or by public-private partnerships allow for purchasing innovative goods and services. A number of such investments are primarily research-driven. This includes the internationally co-financed European Spallation Source and MaxLab in Lund which represent a total investment volume of SEK 17.5 billion. Another major large project is the new Karolinska university hospital in Stockholm, a public-private partnership with a budget of SEK 14 billion, with a large share for new medical technologies. Considerable investments in renewable energy sources and new grids are examples of innovative energy infrastructures.

The interplay between strong university actors, university policy and innovation policy seems to have led over decades to a deadlock which has prevented large-scale, truly strategic interventions. The preferences of university actors for primarily bottom-up strategies with regard to thematic profiling and organisational structure has been solidified by university policy and funding streams, despite recent attempts to introduce performance criteria or to formulate thematic priorities. Strong universities are predisposed to do more of the same in mid-size settings (see similar effects for EU funding, Arnold *et al*., 2008b).

4.8.1. Centre programmes

An instrument that has gained considerable popularity in Sweden is the "centre programme". Over the past two decades Swedish research and innovation policy has placed strong emphasis on the use of co-funded centres to foster science-industry collaboration and substantive co-operation by academic groups. Starting with the NUTEK (and STEM) competence centres in the early 1990s (see Box 4.12), the model has proliferated and most main research funders now have a centre or similar programme in their portfolio. Agencies such as VR, SSF, STEM and VINNOVA, and, to a certain extent, KKS, Formas, FAS and MISTRA all use this model, some with inter-agency collaboration.

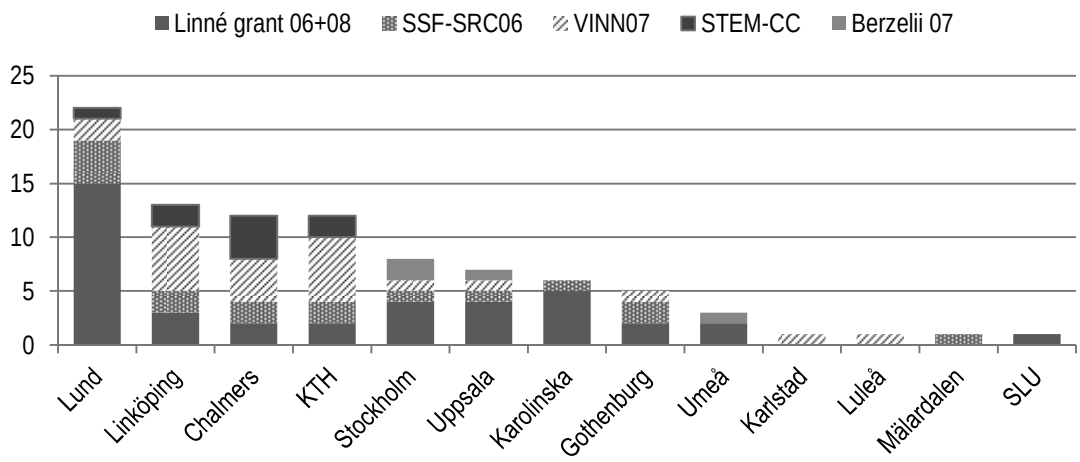
Box 4.12. Sweden's pioneering use of competence centres

During the 1990s, NUTEK established the flagship Competence Centre (CC) programme to fund science–industry consortia. At the time, the CC programme was viewed as one of the most advanced and ambitious technology funding initiatives in Europe. Its overall goal was to shift the research and co-operation culture of the Swedish innovation system towards longer time horizons, more ambitious consortia and lasting organisational and institutional change (Hjorth, 1998; Stenberg, 1997). This approach was based on experiences with the ICT and the materials consortia. The starting point was the 1993 Research Bill. On the basis of strict peer review procedures, the thematically very broad CC selection process introduced an internationally reviewed two-stage procedure. Around 30 centres were selected out of more than 300 applications and the process could be seen as implicit technology foresight and priority setting. CCs were placed at universities which provided one-third of funding through in-kind contributions. The rest came from NUTEK (later VINNOVA) and from industry; each centre included between five and twenty firms which participated in joint research projects in the realm of the CC. At the time, the CCs were quite large interventions and resulted in new dynamics in terms of both research output and the organisational consequences for all actors involved. The programme favoured strong centre directors within existing university structures. The universities could develop more structured relations with industry. Organisational learning included IPR regulations, long-term partnership agreements and joint industry-academia curricula.

Broadly speaking, there are two types of such centres: "excellence" centres that strive for and to some extent reflect scientific excellence; and "competence" centres for more applied and collaborative research with industry. Centres of excellence tend to be organised around one or more internationally renowned scientist and aim to improve collaboration among university researchers and achieve critical mass. Competence centres extend this idea, focusing in particular on industrial impact by concentrating university and industrial innovation resources in multidisciplinary research environments located at universities (VINNOVA, 2004).

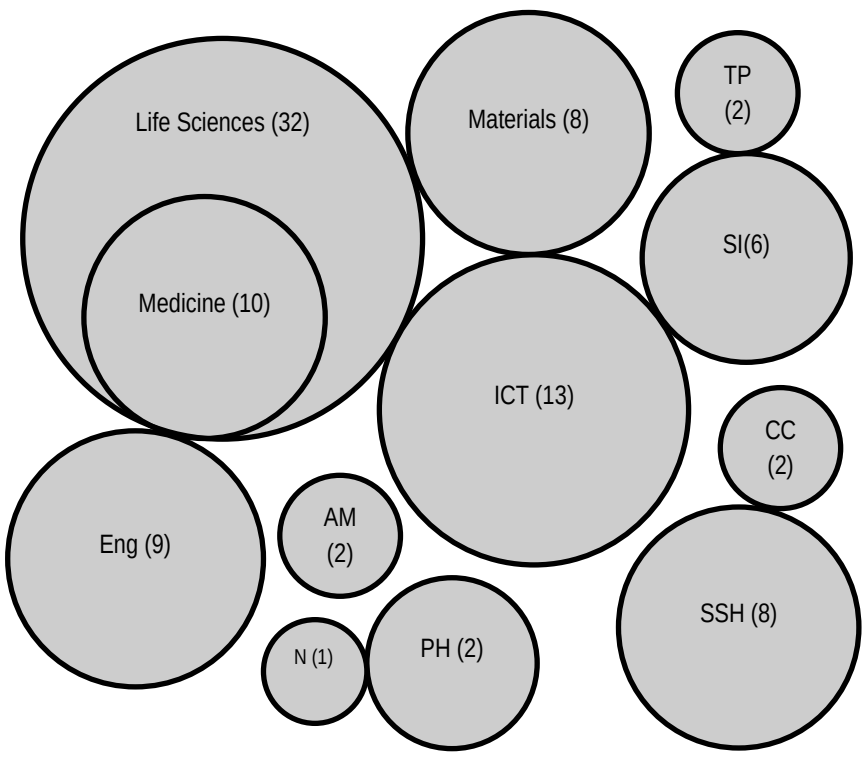
A typical centre runs for five to six years and has an annual budget of approximately SEK 10 million, including industry funding and in-kind contributions from universities. Centres are normally organised within universities and do not operate as distinct legal entities. Centres perform, to various degrees, combinations of functions, including the creation of knowledge, the training of researchers and the facilitation of university-industry interaction, which often includes innovation-related services. Figure 4.3 shows the location of centres by type and indicates the dominance of the older universities, particularly Lund, in their hosting. Figure 4.4 shows the coverage of the centres in terms of scientific fields and the dominance of life sciences research.

Figure 4.3. Centres at Swedish Universities by host university and type, 2011



Source: OECD compilation.

Figure 4.4. Centres by scientific field, 2011



Note: The area of a bubble corresponds to the number of centres in a field. Touching bubbles correspond to interdisciplinary centres in these fields. Of the 32 life sciences centres 10 are in medicine. Abbreviations: information and communication technology (ICT), engineering (Eng), social sciences and humanities (SSH), services and innovation (SI), applied math (AM), physics (PH), transport (TP), climate change (CC), nanotechnology (N). Both transport centres, two of the ICT centres, one in materials science, and one in services and innovation are also labelled as "clean tech". Overall number: 85.

Source: OECD compilation.

Centres of research excellence

VR's Linnaeus Grants was a prominent centre of excellence which endowed host universities with between SEK 5 million and SEK 10 million a year for a maximum of ten years. In two funding rounds (2006 and 2008), VR provided support for a total of 40 "research environments" at universities and university colleges. A 2010 evaluation (Vetenskapsrådet and Formas, 2010) indicates a mixed record. The next call was for "strategic research areas"; 43 research environments were selected in 2009 out of 112 applications. The government will assign approximately SEK 1 300 million annually to this programme from 2012 onwards. The most successful universities in this competition were Lund University, followed by Chalmers University of Technology, Uppsala University, the Karolinska Institutet and the KTH Royal Institute of Technology.

The Swedish Foundation for Strategic Research (SSF) also supports the creation of centres as a way to raise the quality and impact of Swedish research. SSF currently supports 17 centres. Each centre is attached to a prominent scientist, normally in a prestigious university. On average, each centre received SEK 50 million in overall funding for a period of five years from 2006.

Competence centres and research and innovation milieus

A more generic funding activity includes a number of different programme types under the heading "development of strong research and innovation milieus". This category is a blend of the competence centre style of programmes and interventions inspired by innovation systems ideas. The VINN excellence centres, successors of the competence centres, are funded for ten years to produce research that is both multidisciplinary and needs-driven. A large number of partner companies co-fund the 19 centres currently in place. In contrast to the VINN programme, the four Berzelii centres, a joint funding activity of VINNOVA and VR, fund more basic research with industrial relevance. The Institute Excellence Centre programme funds eight centres, mostly in RISE institutes. The Industry Excellence Centres programme targets university based use-oriented long-term research, with a very large industry co-financing element (VINNOVA, 2010, p. 23).

The Swedish Energy Agency (STEM) has contributed on a regular basis to major R&D funding programmes such as the competence centres. In 2009, it funded six larger competence centres for topics such as combustion, catalysis or power engineering at (technical) universities such as Chalmers, KTH or Lund (see Swedish Energy Agency 2009, pp. 4 *ff*.).

Centres as bottom-up priority-setting?

Centre-type initiatives are regularly evaluated and there is a broad evidence base regarding their impact. However, generalisations from such impact assessments are difficult. The record ranges from organisational set-ups that are very successful in mobilising and concentrating resources to very loose networks. Organisational set-up and governance strength varies considerably. While there are examples of well-structured co-operative research strongholds, others may be better described as umbrella structures for segmented research groups with little substantial integration.[27]

Lack of sufficient size is an often cited concern and is seen as an important obstacle to achieving greater impact. International comparisons can be revealing in terms of ascertaining orders of magnitude, although insights drawn from such comparisons are, at best, tentative, as the scale of centres very much depends upon their disciplinary and

even functional (experimental, analytical) specialisation. As a whole, average centre funding in Sweden stands close to the SEK 10 million a year mark. This compares unfavourably to other countries with developed innovation systems. For example the German Excellence Initiative has a total volume of SEK 19 billion for the period 2007-12, and each of the current 37 clusters of excellence receives an average of SEK 65 million a year. Life sciences facilities in the United Kingdom (an area in which Sweden is also specialised) are endowed with much larger budgets and manpower (Reeve *et al*., 2009, p. 51). Similar initiatives, such as the Austrian COMET centres, also tend to be larger. While Sweden has some larger-scale initiatives such as the Stockholm Resilience Centre co-funded by MISTRA, the impression of many mid-sized initiatives prevails. Of course such centres attract third-party funding and have a strong influence on resource allocation and are therefore somewhat larger than they seem to be. Nevertheless, the diffuse nature of their resource mobilisation may contribute to universities' and funding agencies' difficulties in setting priorities. At the same time, the prevalence of centres as a policy instrument may be symptomatic of the limits on formal priority setting in a fragmented funding landscape.

This review does not propose curtailing such programmes, as they all belong to the comparatively dynamic part of the Swedish funding system. However to bring this kind of intervention to the next level it might be important to evaluate them from a systemic perspective: portfolio issues, questions of incentives, structures, size and numbers. It would be most important to streamline policy and organisational priority setting (which is currently weak) and bottom-up priority setting (which is currently strong). Such an exercise could address three questions: Do centre programmes act as a substitute for a weak ability to set real priorities at various organisational levels? Do the centre programmes mirror problems in the set-up of the funding system (valuable as they may be)? Can these centre programmes exert pressures for change on academic and other Swedish actors? While examining the current organisational and managerial strengths or weaknesses of the centres themselves may be useful, it does not address such systemic issues.

4.8.2. Getting more from universities

The main recommendation is to expect more from Swedish universities. The top Swedish academic institutions should aim to improve their record in excellence as well as their position in providing good services for society at large as well as industry. Such moves are in fact already being taken, but not on a level that is ambitious enough for the high reputation of the universities, their central position in the Swedish research system and their good financial basis.

In general the strategy should be to help make the traditional universities stronger and more proactive players in the innovation system. In this context the work on university profiling and the strengthening of organisational leadership should continue. With greater autonomy, HEIs should be subject to stronger accountability regimes through research assessment of block grant allocations (which should not shrink) in order to reward research excellence. It is important to foster differentiation within and between institutes and to allow for greater specialisation and the build-up of large centres of excellence. This can be done through larger centres created by agency/foundation programmes. At the same time, the HEIs should be more strongly encouraged to foster the build-up of critical mass internally. Larger and better structured centres are also able to improve the interface with industry (including SMEs) and the public. Universities should become more outward-looking and entrepreneurial, raise the number and share of

industry contracts, and develop an active IP strategy. An early review of the innovation offices established by HEIs should be conducted.

Recruitment is also important and there is little reason why Sweden cannot attract top talent from all over the world and research facilities from abroad (instead of just fearing to lose what it has). Measures in this context have to deal with the attraction and retention of top researchers from abroad, particularly in the universities, *e.g.* along the lines of the Swiss ETH sector. The aggressive international recruitment strategies of some top European universities and the structures they offer as a host organisation could be worth studying to increase Sweden's chances in the international competition for talent. The role of Sweden's universities in hosting foreign students and researchers could be further strengthened. Foreign-born students and researchers play an outstanding role in the commercialisation of research in some of the leading centres of research and innovation, *e.g.* Chinese and Indian researchers in Silicon Valley.

For the new and smaller universities, their distinctiveness *vis-à-vis* the leading research HEI should be maintained, while R&D support should be continued. Sweden should consider consolidating some university colleges into single entities with critical mass and possibly include some of the RISE institutes in these efforts. This will be important for managing the impacts of demographic change, which threatens the existence of some smaller institutes.

4.9. Promoting balanced growth across regions

In many countries, efforts to co-ordinate innovation policy have been affected by a growing regionalism, in which more control over policy and resources is devolved to sub-national authorities. This movement has seen the emergence of innovation, and increasingly science, agendas at the sub-national level. Several countries report specific arrangements to improve co-ordination between different levels. For example, institutionalised forums – in the form of roundtables or policy councils – are reported by Argentina, Australia, Brazil and Denmark, while Spain relies on the articulation of STI collaboration agreements between state and regional governments. In the European Union structural and cohesion policies have been developed to counterbalance strong regional disparities between and within member states, with the Structural Funds (SF) as the main instrument to finance projects and infrastructures.

4.9.1. Regional innovation capacities in Sweden

Sweden places much emphasis on spatial equity and balanced regional development (Henning *et al*., 2010). While economic activity is concentrated in the south of the country, Sweden's less favoured regions are developed by international standards. This has been partly achieved through interregional transfers in the form of infrastructure investments and the universal provision of public services across sparsely inhabited areas characterised by long distances and cold winters. Some of these regions profit from a strong traditional industrial base in sectors such as mining/metallurgy or wood/pulp and paper. Others have specialised in smaller niches such as car components or specialised services. For research and innovation, a number of less favoured regions have quite a few strongholds such as universities or corporate R&D centres. Some regions have a good innovation record, as illustrated for instance by successes in high-voltage power transmission and automotive safety.

Nevertheless regional disparities are strong and the better-off regions in the southern part of the country continue to absorb the lion's share of resources for innovation and account for the majority of formal R&D. Comparing the regions at the NUTS 2 level, Southern Sweden (Sydsverige) leads with R&D expenditure of some 5% of gross regional product (GRP) in 2007 (Eurostat 2011, p. 39), while the least research-intensive region, Mid-Northland (Mellersta Norrland), has R&D expenditure of less than 1% of GRP. Sweden is not unique in this regard, as R&D activities everywhere tend to concentrate in a small number of regions. Countries with strong innovation performance all show strong within-country disparities in the distribution of R&D activity. Sweden shares wide interregional disparities with Finland and Denmark, and Germany's regional R&D imbalances are even more pronounced. R&D facilities and research organisations are concentrated in Southern Sweden around Stockholm/Uppsala and in Western Sweden (Västsverige), which has many academic and industrial research performers. Nonetheless, strong universities such as Umea or Lulea and active innovation clusters can be found in more remote areas such as Upper Northland (Övre Norrland). The first three regions combined account for 70% of national R&D spending: Stockholm 33%, Västra Götaland 21.7%, Skåne 15.3% (SCB, 2011, p. 9).

When considering the more detailed NUTS 3 level, which corresponds to Sweden's 21 counties, the three strongest, Stockholm, Västra Götaland and Skåne, made up more than 50% of the population and 57% of the national output in 2005 (OECD, 2010, p. 46). This share had been growing over the last decades. In terms of entrepreneurship, nearly 60% of all start-ups are created in these three regions, but long-term comparisons show stronger growth rates in the more remote regions.

Internationally, Swedish regions compare very favourably. Four Swedish NUTS 2 regions are among the top 20 regions for research and technological development (SCB, 2011, p. 15). Four Swedish regions were among the top 30 in Europe in patents at the European Patent Office (EPO) in 2006 (Eurostat 2011, p. 114). Human resources in science and technology (HRST)28 tend to cluster in central hubs. Across the top 30 regions in Europe, Stockholm ranks number 2 with more than 47% of knowledge workers in the labour force, and Southern Sweden (36.8%) is also among the top 30 (2009) (Eurostat, 2011, p. 72). By comparison, six Swiss and four Dutch regions are in the top 30.

4.9.2. Regional innovation policy

Swedish regional policy is best described as an "hourglass" (OECD, 2010), with a weak intermediate regional level between the politically important national and local levels, the only two enshrined in the Swedish constitution. Though efforts have been made to strengthen the middle level, the description remains valid. On the national level, there are small ministries and a multitude of strong, relatively independent agencies. The *OECD Territorial Reviews: Sweden* (OECD, 2010) counts 400 agencies in all policy fields, nearly all of them with regional outlets. However, co-ordination challenges related to regional policies are often tackled in a centralised manner through horizontal government (and agency) co-ordination with independent actors in a consensus oriented society. Committees of State Secretaries are tasked with the smooth delivery of horizontal government policies.

While many policy areas are a federal prerogative, important public services such as education, social services or local infrastructures are provided by the 290 municipalities. They, together with the national level, have a high taxation capacity. In contrast to the

national and the local levels, which have ample resources and clear responsibilities, the regional level has few resources. The eight NUTS 2 regions (*Riksomraden*) appear to exist largely for statistical reasons, although there have recently been calls for fewer, larger and more powerful regions (OECD, 2010). At the NUTS 3 level, Sweden's 21 counties (*Län*) have existed for centuries (OECD, 2010, p. 6), with county councils mainly responsible for health care. Such tasks represent 80-90% of the county budgets. Counties have both administrative boards for regional co-ordination of national policies and county councils dealing mainly with health affairs.

The path from uniform policy approaches to regionally differentiated ones has included a number of steps, largely driven bottom-up. In the late 1990s, the two strong regions Skåne and Västra Götaland were accorded the status of pilot regions with directly elected regional authorities. These new bodies took over responsibilities for regional development from the state agencies that co-ordinated the multi-agency activities at the regional level (country administration boards). This introduced a stronger bottom-up approach and led to the mobilisation of additional regional actors and to the formulation of regional development and innovation strategies. Skåne extended its ambitions, first by forming the Öresund region with Copenhagen in Denmark when the two countries were linked by a bridge, and second by pursuing co-operation strategies in the Baltic region. Two smaller Swedish regions – Kalmar and Gotland – have experimented with similar approaches. Further regional policy steps in the mid-2000s were less ambitious and led to the formation of (weaker) regional co-ordination bodies. At the end of the 2000s there were calls for further regionalisation and a number of initiatives to merge countries into larger regions with more powers. For cross-sectoral policy co-ordination and for the management of EU Structural Funds, two planning instruments were introduced: regional development programmes provide for umbrella strategies and regional growth programmes for more concrete action. However these plans do not always seem to result in co-ordinated action and often play a limited role in both horizontal and vertical co-operation (Tillväxtverket, 2012).

For regional innovation policies, Sweden and Swedish regions have developed different instruments over the last 20 years and there already some notable examples of good practice (see Box 4.13) The instruments have changed but not necessarily the rationale: territorial equity is still considered important, although redistributive and infrastructure policies no longer suffice to achieve it. Therefore, endogenous innovative potential and regional competitiveness are to be supported, whether new tourism services or high technology. This approach, which exists in many industrialised countries, goes hand in hand with experimental devolution of powers, multi-level governance of innovation, and the move to a more interactive process of innovation policy programming and performance.

The conduct of regional innovation policy is still in its early stages, but is evolving rapidly. Starting with rather informal co-ordination bodies and cluster initiatives, regional innovation policy approaches have become more formalised and are higher on the policy agenda. A further push and formalisation came with the Structural Funds and the territorial activities in EU innovation policies such as the RIS (Regional Innovation Strategies) and the RITTS (Regional Innovation and Technology Transfer Strategies and Infrastructures). Regional competitiveness is now a strong driver of regional development policy and innovation policy, bringing the two fields closer together with a view to activating endogenous regional potential.

Box 4.13. Skåne's regional innovation policy

Skåne's regional innovation policy is a good model to follow to address the frequent weaknesses of regional innovation policies. The core ingredients that make Skåne's regional innovation policy a good prototype for the new wave of policies are the following:

- The role of public authority is to act as a facilitator of change and catalyst of interfaces. The role of Skåne Region is to improve conditions for innovation, notably by supporting platforms for increasing synergies between actors from the region and beyond.
- The policy goal is to improve system coherence, resilience and evolution capacity. This is a difficult role which requires much more policy intelligence and efficient policy mixes, than the traditional role of resources allocator.
- Interventions are selective and concentrated, targeting promising growth areas and concentrating resources on those areas with a view to build critical masses in world-class excellence clusters. This capacity of selecting priority areas has been developed both thanks to good knowledge of the regional potential and through a bottom-up process to leverage knowledge present with existing actors.
- The strategy is outward-oriented, as it takes into account Skåne as a functional region rather than being confined to administrative borders, and sees the region's specialisation in an international perspective. Cross-border policies are present and the very goal of regional interventions is to bring regional actors on the international scene.
- The strategy combines effective leadership and strong stakeholder involvement: it is the result of a collective endeavour led by Region Skåne, perceived as a legitimate leader, and involves the academic world, public authorities and the business community as well as innovation users. The recent establishment of the FIRS and the SIS testifies the drive towards enhanced stakeholders involvement.
- The approach is experimental and evidence-based: in addition to the contribution of regional stakeholders, the strategy is nurtured by numerous studies, expertise, and peer reviews and the analytic knowledge at the disposal of decision makers is remarkable.

Source: OECD (2012b, p. 155).

The pilot regions (Skåne and Västra Götaland) have made progress through the mobilisation of actors and explicit planning processes and by devoting more local and regional financial resources to innovation. A number of incubators and technology centres are being financed at the regional level. The early 2000s saw specific national cluster initiatives. However, national policy makers are to a large extent still in charge of conduct of innovation policy in the regions.

National bodies are often in a difficult position as they are numerous, have co-ordination problems (OECD 2010a) and deal with a variety of actors with different mandates in different regions. These encounters seem to have led to experimentation and tailor-made support strategies.[29] At the national level in 2009 there were 1 500 ongoing regional projects (funded by some 30 public bodies). The national/non-EU projects co-financed by Tillväxtverket play the most important role, with more than SEK 1.2 billion in overall funding, a relatively small share of Tillväxtverket funds. Nearly half of these funds are allocated for innovative entrepreneurship (Tillväxtverket, 2010b, p. 33). Tillväxtverket gives high priority to the promotion of this kind of entrepreneurship: as an example, one of its programmes, SADD, aims at revitalising business through start-up financing of development costs for technologically innovative product ideas. In 2009, it disbursed SEK 36 million to 258 new firms (Tillväxtverket, 2010b, p. 35; see also section 4.5).

Table 4.2. Projects selected by the VINNVÄXT programme

Topic	Region	Description
ProcessIT Innovations (*www.processitinnovations.se*)	Luleå/Umeå	Developing new services and products in mining, steel, paper and pulp and manufacturing industries based on ICT. Involves processing and manufacturing industries, the universities of Umeå and Luleå, and ICT companies in Västerbotten and Norrbotten.
Biomedical Development *(www.goteborgbio.se)*	Western Sweden	Converting cutting-edge innovation into practical applications in biomaterials, cellular therapy, and cardiovascular and metabolic diseases.
Triple Steelix *(www.triplesteelix.se)*	Bergslagen	Increasing expertise in steel materials, steel processing, nanotechnology, industrial IT, the environment and energy efficiency. Involves major companies such as Sandvik, Outokumpu and SSAB.
Fiber Optic Valley *(www.fiberopticvalley.com)*	Hudiksvall	Developing and testing products and services based on fiber optics. Offering a test bed with contracted test pilots, qualified evaluators, research, training, business models, behavioural analysis, statistical models and an advanced fiber laboratory.
Hälsans Nya Verktyg (New Tools for Health) *(www.halsansnyaverktyg.se)*	Östergötland	Developing individually adapted solutions in distributed care, personal care and sports. Involves some 60 companies, the municipalities in the county, the county council, the regional association Östsam, NGOs, Linköping University and research companies.
Uppsala BIO *(www.uppsalabio.com)*	Uppsala	Promoting the growth of diagnostics, tools for biotechnological research and pharmaceuticals. Involves the local biotechnology industry, the university and the public sector.
Robotdalen (Robot Valley) (*www.robotdalen.se*)	Mälardalen	Fostering research, development and manufacture of industrial, field, and medical robotics. Mobilising major companies such as ABB, Atlas Copco and Volvo.
Food Innovation at Interfaces *(www.innovationigransland.se)*	Skåne	Increasing the return on investments and value generation in the foodstuffs industry (e.g. food for schools and hospitals), based on interdisciplinary and cross-border research.
Biorefinery of the Future *(www.processum.se)*	Örnsköldsvik-Umeå	Developing new bio-based green products, chemicals and fuels as well as new energy solutions from industrial process streams based on forest raw materials and energy crops.
Peak of Tech Adventure (*www.peakoftechadventure.se*)	Åre-Östersund	Promoting R&D in winter sports, tourism and outdoor pursuits. Involves two international competence centres for the tourism industry (ETOUR) and winter sports (Swedish Winter Sports Research Centre).
Smart Textiles *(www.smarttextiles.se)*	Sjuhärad	Designing, developing and producing next-generation textile products (e.g. greenhouse fabrics, wound care products and sound-insulating textiles) by joining different competences (e.g. textile materials, electronics and medicine).
Printed Electronics Arena *(www.printedelectronicsarena.com)*	Norrköping/ Linköping	Commercialising and exploiting printed electronics (*e.g.* displays and sensors for packaging and security industries).

Source: OECD (2010) based on VINNOVA.

VINNOVA provides additional national funding for innovative regional activities. Its VINNVÄXT programme in particular aims to create functional regions united by a common topic beyond county borders, the ultimate goal being a significant contribution to regional economic growth (Andersson *et al*., 2010). The programme was established in 2001, with subsequent calls in 2003, 2004 and 2008. The aim is to further develop existing strengths within such functional regions by way of "triple helix"[30] collaboration of industry, academia and public administration. The 12 selected "projects", *i.e.* regional consortia (Table 4.2), get long term-funding. They cover all of Sweden and include a wide range of topics from process/IT innovations in the Umea/Lulea area to the "Triple Steelix" in Mid-Sweden to the Skåne Food Innovation Network. The consortia have to demonstrate stability but the co-ordinating host can take different forms. VINNOVA can contribute an annual subsidy of a maximum of SEK 10 million per project. Besides the triple helix approach, the *OECD Territorial Reviews: Sweden* (2010) lists a number of policy directions, including a focus on regional comparative advantages based on preparatory work; a ten-year funding period with two interim evaluations; VINNOVA process support; and an emphasis on cross-sectoral, interdisciplinary and collaborative perspectives on needs-driven research, coupled with a foresight element. The entire VINNVÄXT programme has undergone an interim evaluation (Andersson *et al*., 2010) which examined its processes and its first elements of success. While the programme was deemed successful, the evaluation highlighted some areas for improvement. For the most part, these relate to challenges for regional innovation policy instruments everywhere, rather than issues unique to the programme. The most relevant issue in the Swedish context is the rather unclear governance structures in this policy area and the difficulties consortia face for influencing and shaping regional strategies.

4.9.3. EU Structural Funds and regional innovation

The EU Structural Funds are an important instrument of regional innovation policy in Sweden. One important function of the Structural Funds is to leverage and mobilise regional and local resources in Sweden in line with European strategic priorities. Previously, EU regional funding supported mostly physical infrastructures with an overall focus on poorer or more remote regions, but the current period (2007-13) puts much stronger emphasis on innovation (an emphasis which appears likely to increase over 2014-20) and formally covers the whole country. Some of the most intensive users of Structural Funds for research and innovation are peripheral, less innovative regions in "old" EU15 countries. This group, which uses more than one-third of Structural Funds for research, innovation and the business environment, includes all mid- and northern Swedish regions. The pattern is similar for mid- and northern Finland, the north of the Netherlands, northern England, eastern Germany or the rural parts of eastern Austria (European Commission, 2011)

In Sweden the largest share of funding is still directed to the sparsely populated northern regions. In the current period, the Swedish Structural Funds budget for regional development (funded by the European Regional Development Fund, ERDF)[31] accounts for more than SEK 8 billion (Tillväxtverket, 2010a, p. 1), is divided into eight regional Operational Programmes and is co-financed by national funds. For example, in 2009 all EU co-funded (ERDF) projects reported an available budget of SEK 3.2 billion, including Swedish co-financing (Tillväxtverket, 2010b). The entire ERDF programme is administered by Tillväxtverket, including management of applications, funding decisions and monitoring progress. The agency therefore handles more than 1 000 Structural Funds projects with total funding of more than SEK 20 billion from different sources. A

number of regionalised national actors and funding initiatives are co-financed in this manner, including Innovationsbron, Norrlandsfonden, Almi, among others.

In principle, more than 90% of the Structural Funds in Sweden are devoted to "innovation and renewal" and support many local and regional initiatives to enhance regional competitiveness, in contrast to the earlier objective of compensation for location disadvantages (OECD, 2011). In practice however, the shares of core research and innovation may be considerably smaller (Rivera Leon *et al*., 2011, p. 38) as the goals and targets are very broad and allow for many different types of intervention.[32]

4.10. Promoting innovation in the public sector and wider society

Innovation agendas in Sweden, as in other OECD countries, have traditionally focused on S&T developments that benefit business innovation, particularly product innovation in manufacturing firms. It was already recognised in the 2004 Innovative Sweden strategy that this focus is too narrow for a national innovation agenda. The argument has been picked up again in the new Swedish Innovation Strategy, which gives much space to public-sector and social innovation.

4.10.1. Public-sector innovation

There is increased appreciation among policy makers that the public sector must learn to innovate. Major challenges face the public services across the OECD area, including climate change, rising demand for health care, rapid population ageing and expectations of rising service quality. At the same time, the global economic crisis and reduced fiscal space in many countries are putting pressure on governments to find more efficient and cost-effective methods of delivery (in a context where the cost of public services tends to rise faster than in the rest of the economy owing to a lack of public-sector competition and because labour efficiency gains tend to occur more slowly than gains in capital efficiency). Policy makers increasingly look to innovation to help meet such challenges, but to date, there have been few incentives to innovate in public-sector organisations and the risks associated with innovation have been high.

Public-sector innovation takes many forms, but one increasingly present technological feature is the intention to fully use the potential of ICTs. This is associated with measures aiming to increase the availability and use of government data. Other relevant forms of innovation also have to do with the organisational and operational structure of the public sector (for instance, altering the number of government departments, creating public-private partnerships and creating independent regulatory agencies).

Knowledge of how countries have implemented innovative approaches in the public sector is still fragmented and a common definition of what innovation means for public-sector organisations is lacking. More needs to be done to understand the boundary between public-sector reform and innovation. Sweden has played an active part in trying to develop the knowledge base, *e.g*. through Nordic efforts to improve the measurement of public-sector innovation (Box 4.14). At an international level, the OECD's Public Governance Committee has established an Observatory of Public Sector Innovation with a similar purpose. Its aim is to create a knowledge base on how governments are using innovation in the public sector with a view to improving performance and achieving policy goals. The Observatory provides an instrument to collect, categorise, analyse and monitor innovative practices in the public sector systematically; a centre for seeking and developing new ways to make innovation work in practice; and strategies and

frameworks to promote and steer innovative behaviour in the public sector. The Observatory is steered by a Task Force of 21 countries, including Sweden, which is represented by the Swedish Agency for Public Management.

Box 4.14. The MEPIN project: Towards a conceptual and practical framework for measuring public-sector innovation activities

The MEPIN (Measure Public Innovation) project is part of a Nordic project on measuring public-sector innovation that includes, among others, VINNOVA, Statistics Sweden, and the Swedish Association of Local Authorities and Regions. The first stage of the project involved the development of a preliminary conceptual and survey framework for measuring public-sector innovation. This was followed by a pilot study involving the distribution of a common innovation survey type questionnaire among public-sector organisations in Denmark, Finland, Iceland, Norway and Sweden.

Among other things, the project offers a useful typology of innovation which builds on the conceptual framework of the *Oslo Manual* and modifies it to make it more suitable for the public sector. An explicit objective of the definitions used by MEPIN is to maintain some degree of comparability with the OECD/Eurostat *Oslo Manual*, while taking account of the nature of the public sector. Accordingly, innovation is defined as the implementation of a significant change in the way an organisation operates or in the products it provides. Innovations comprise new or significant changes to services and goods, operational processes, organisational methods, or the way the organisation communicates with users. This overall definition covers four broad types of innovation in public-sector organisations.

- A *product innovation* is the introduction of a service or good that is new or significantly improved compared to existing services or goods in the organisation. This includes significant improvements in the service's or good's characteristics, in customer access or in how it is used.
- A *process innovation* is the implementation of a method for the production and provision of services and goods that are new or significantly improved compared to existing processes in the organisation. This may involve significant improvements in, for example, equipment and/or skills. This also includes significant improvements in support functions such as IT, accounting and purchasing.
- An *organisational innovation* is the implementation of a new method for organising or managing work which differs significantly from existing methods in the organisation. This includes new or significant improvements to management systems or workplace organisation.
- A *communication innovation* is the implementation of a new method of promoting the organisation or its services and goods, or new methods to influence the behaviour of individuals or others. These must differ significantly from existing communication methods in the organisation.

Source: Adapted from Bloch (2010).

The Swedish government is clearly serious about promoting public-sector innovation. It recently established the National Council for Innovation and Quality in the Public Sector to improve the efficiency and quality of public activities at national, regional and local levels. The Council aims to support and stimulate innovation and change in public services through analysis and proposals of measures to promote innovation and development in the public sector. It is due to report in mid-2013. Public-sector innovation also features prominently in the government's new innovation strategy, as it did in the earlier strategy. The issue seems to be that the funding agencies have yet to make sense of what it means for their research and innovation agendas. Swedish innovation policy continues to place considerable emphasis on support for R&D and innovation in manufacturing firms, but this view needs to be broadened to cover all aspects of innovation. In other words, the government should look to implement a broader innovation policy that it does at the current time.

The government should also continue to support a better conceptual and empirical basis for measuring and promoting public-sector innovation and should develop and implement experiments in the public sector to nurture innovation. It will be important for know-how regarding public-sector innovation to reach the regional and municipal levels. Likewise, lessons from experiments at regional and municipal levels should be widely shared.

4.10.2. Social innovation

Although widely used, the notion of social innovation has not yet been fully explored and many definitions exist (see Box 4.15 for an OECD definition dating from 2000). Nevertheless, the term has been widely used to refer to different ideas and approaches for addressing unsolved social problems: social innovation is needed because many social challenges resist conventional approaches (OECD, 2010b).

Box 4.15. Social innovation: An OECD definition

Social innovation seeks new answers to social problems by: identifying and delivering new services that improve the quality of life of individuals and communities; identifying and implementing new labour market integration processes, new competencies, new jobs, and new forms of participation, as diverse elements that contribute to improving the position of individuals in the workforce.

Social innovations can therefore be seen as dealing with the welfare of individuals and communities, both as consumers and producers, and with the quality of their life and activities. Social innovations always involve new references or processes.

Social innovation is distinct from economic innovation because it is not about introducing new types of production or exploiting new markets but about satisfying needs not provided for by the market (even if markets intervene later) or about creating new, more satisfactory ways of insertion in terms of giving people a place and a role in production.

The key distinction is that social innovation deals with improving the welfare of individuals and communities through employment, consumption and/or participation, its expressed purpose being to provide solutions for individual and community problems.

Source: OECD LEED Forum on Social Innovations, *www.oecd.org/cfe/leed/forum/socialinnovations.*

Social innovation and social entrepreneurship in Sweden are relatively new concepts, but as activities have a long history. Social innovation is seen as a means to create new business opportunities and growth while solving social challenges, particularly in the areas of health, medical care, education and green industries. Nonetheless, according to the Social Innovation Europe website,[33] Sweden is in need of national and regional policies and strategies to promote social innovation more systematically. Specifically, new kinds of partnerships are needed, including new methods of financing social innovation (some municipalities have developed social investment funds, but more is reported to be needed). Perhaps the biggest challenge is in raising awareness of social innovation, not only in society at large but also in government ministries and agencies responsible for promoting the development of business, trade and enterprise on a national level. In this regard, the Knowledge Foundation has sponsored the set-up and operation of the Forum for Social Innovation Sweden (see section 3.4). A major aim of the Forum is to raise awareness of social innovation and to advocate its inclusion in mainstream innovation policy agendas. As with public-sector innovation, the government should look to implement a broader innovation policy that includes social innovation as one of its core pillars.

4.11. Building and exploiting international knowledge linkages

In today's world, to be successful in science, technology and innovation countries must be closely linked to and embedded in international knowledge networks and attract and retain talent and knowledge-intensive investments. To address the so-called "grand challenges", including the greening of economies and major health and food security issues, whose scale and scope extend well beyond national borders, they must also participate actively in international agenda-setting and co-ordinated actions.

This report has highlighted the role of openness and internationalisation in Sweden's economic and social development. Indeed, Sweden has embraced internationalisation and globalisation (see Globalisation Council, 2009) more readily than most other countries. The openness of the Swedish economy but also its egalitarian political and societal values have nurtured a traditionally proactive international policy. Most of the agencies and foundations that undertake national policy tasks have programmes and initiatives with an international scope. Sweden is also strongly and successfully involved in EU research policy and notably in the R&D- and innovation-related Framework Programmes, which figure on the agenda of most public and private funding organisations. Some, like the Space Board (SNSB) through its payments to the European Space Agency, see their international contribution as a main task.

4.11.1. International resources: Sweden in the European research and innovation framework

Sweden joined the European Union in 1995, together with Finland and Austria. Neighbouring Denmark was already a member, and Norway decided not to join. For research and innovation, this meant better access to European funding through the EU Framework Programmes and more recently through Structural Funds. Even before 1995 Swedish research actors joined European consortia on a shared cost base, funded by NUTEK. FP3 (1990-94) gave Sweden its first opportunity to collaborate in an organised manner. Over ensuing FPs, Sweden's participation, co-ordinating role and funding inflows increased dramatically. In FP6 Sweden ranked first in Europe in European funds granted per capita (Arnold *et al*., 2008b, pp. 28 and 38). The effects of Structural Funds are mostly felt on the level of the regions and communities; they are discussed below.

While Sweden generally fares very well in the Framework Programmes, its position is not exceptional when compared to its strong domestic research base. It ranks 13th in number of participations in FP7 per 1 000 researchers for 2007-09. Greece, Estonia and Slovenia are in the top group along with Switzerland, the Netherlands and Belgium (European Commission, 2011, p. 261). In Sweden, EU funding represents around one-third of the funding issued by VR, FAS, FORMAS, VINNOVA and STEM (VINNOVA, 2010, p. 23). EU funds represent nearly 14% of overall central government budget appropriations for R&D (GBAORD), of which more than 10% from FP7 and about 3% from the Structural Funds. This relation is typical for highly developed, R&D-intensive EU member such as Finland, Austria, the United Kingdom or Belgium (European Commission, 2011, p. 255). By comparison, the EU average is 16% (9% FPs and 7% Structural Funds).[34]

Overall, the use of Structural Funds for R&D is rising steadily. About 20% of these cohesion instruments are now earmarked for research and innovation, with an upward trend foreseeable in the next period (2014-20). Some of the most intensive users of Structural Funds for research and innovation are peripheral, less innovative regions in "old" EU15 countries.

Sweden has been active in policy on the European level and has been able to influence the agendas of current and future European programmes and policy initiatives. Recent examples include the establishment of the European Research Council (ERC) and the structuring of the upcoming Framework Programme, currently called Horizon 2020. VINNOVA acts as Sweden's national contact for EU FP7 funding. It also gives help to Swedish applicants and helps them organise networks and establish common positions. Sweden is one of Europe's leading advocates for a stronger and more structured perspective on European research and innovation policies and instruments.

The European Framework Programmes as a major funding source for Swedish universities

While both the ERC and the European Institute of Technology (EIT) were only introduced with FP7, Sweden has participated in through collaborative FP projects since 1990. A comprehensive study of the impacts of the framework programme in Sweden (Arnold *et al.*, 2008b) revealed that although Swedish companies were initially the major participants, Swedish universities regularly increased their participation and by FP6 about 60% of FP funding to Sweden went to the university sector. Overall Sweden gets more money back than it contributes. Broken down by individual Swedish universities, the most successful are, not surprisingly, those with the strongest overall research performance.

The FPs are the second largest funding source for universities after the Swedish Research Council. They have added diversity and robustness to already strong individual research groups which have been able to increase their European scientific networks and be part of "invisible colleges" in which leading-edge research is circulated among "insiders" prior to publication. In addition, FP projects are typically more interdisciplinary than the projects funded by the Swedish Research Council. Doctoral education has also benefited from FP participation owing to increased exposure to the international level and to applied research. Structured project management also helps to extend the skills set of doctoral students. This is important because Sweden suffers from low post-doc mobility within Sweden and internationally and also from "reverse internationalisation", *i.e.* the number of Swedish students studying abroad is quite stable while that of international students studying in Sweden has increased significantly. However, this increase came to an abrupt halt in the first half of the 2011/12 academic year when full-cost student fees were introduced for non-EU/EEA nationals at Swedish universities.

According to Arnold *et al*. (2008), FP participation has not been used as a strategic tool. There are some indications that Sweden has missed opportunities to build up new science-industry relationships that go beyond established pairings of academic and industrial actors. As university networks and industry networks largely evolved separately, the participation of Swedish universities in the FPs has rarely had a significant influence on industrial innovation. However, this has been essentially due to the structures and instruments of the FPs, which favour opportunistic behaviour and "more of the same" as long as it involves international consortia.

Finally, the "triple helix" instrument of The European Institute of Technology (EIT) has made it possible to establish some strong nodes in knowledge and innovation communities (KICs)[35] and to bring together industry/entrepreneurship, research and teaching. Another large-scale innovation in FP7, the ERC, provides competitive, well-endowed grants for top researchers across Europe. Sweden's record has been very good but not excellent; it could be better for a country that is an innovation leader with high inputs in academic research.

The European Framework Programme and its impact on industry

Only a few Swedish firms are among the strong, recurrent FP actors. For many years, five large industrial conglomerates dominated: Volvo, Ericsson, Saab, Vattenfall and Telia/Teliasonera (Arnold *et al*., 2008b, pp. 28 and 34). Overall, industry's share in FP participation has declined considerably over the years. This is in line with developments in similar member states and says more about the FPs than about Swedish industry's readiness to collaborate on an international level. Nevertheless, industry participation in FP6 and the first years of FP7 has been low in international comparisons. The share of financial contributions allocated to industry participants was average in FP6 but is the fourth lowest in FP7 so far. The share of SMEs participating in FP7 is also at the low end, at 12% of all participations, as in Finland or Denmark. For overall shares of industry participation, the numbers are slightly better (European Commission, 2011, pp. 342 *ff*.).

A long-term analysis of FP participation shows differences among sectors. The car industry has been able to profit from the FPs and has participated strongly. This has been due to the small number of (large) firms, individual firm strategies (which helped some key capacities to survive) and the ability to do precompetitive, pre-standardisation work with competitors. Similar patterns are observed in the ICT industry, where Ericsson and a few others also profited from pre-standardisation work. The sustainable energy sectors participated and benefited much less owing to the sector's fragmented nature and difficulties for entering core networks. In the life sciences the picture is mixed and strong initiatives driven by Swedish actors are lacking (Arnold *et al*., 2008b). The analysis did not find a significant impact on SMEs and their R&D capacity building.

4.11.2. Development co-operation and other forms of co-operation

The Swedish International Development Cooperation Agency (SIDA) acts as a government agency under the auspices of the Ministry of Foreign Affairs. It organises Sweden's traditionally strong international development co-operation effort to improve the living conditions of the poor (Forskning.se, 2009, p. 8). SIDA has a large R&D budget of more than SEK 1 billion a year, mostly for research co-operation, contacts, training and projects abroad. About a third of the agency's R&D budget is earmarked for research in Sweden on areas of value for developing countries.

The Swedish Foundation for International Co-operation in Research and Higher Education (STINT) is a smaller public foundation with SEK 60 million annually for increasing Sweden's international co-operation on research and education (Forskning.se, 2009, p. 16). Founded in 1994, STINT supports the expansion of academic networks and offers a variety of instruments for incoming and outgoing scholars as well as for institutional contacts. Countries such as Korea and Brazil have been specifically targeted.[36]

Individual national actors also provide money for international collaboration. The joint call of Riksbanken Jubileumsfond, the German Volkswagen Foundation and the Compagnia di San Paolo of Italy offers one example. These three independent foundations

decided in 2003 to "promote … the emergence of a new European generation of researchers with roots outside their own home countries" (Riksbanken Jubileumsfond, 2011, p. 26). The programme ran until 2010 and allowed a number of junior researchers to advance their career and to carry out research across Europe.

Invest Sweden has done some exploratory work with science parks on improving opportunities for strategic alliances with and investments from overseas firms. In promoting exports not linked to development goals, the Swedish Export Credit Guarantee Board (EKN) and the Swedish Trade Council (Exportradet) also support innovative companies.

Sweden strongly promotes integration in the Baltic Sea region through initiatives such as co-operation in energy, telecommunications, environment or health with partners in more than ten countries. VINNOVA and the Ministry of Enterprise, together with Polish authorities, co-ordinate the creation and growth of innovation environments (Innovative Baltic Sea Region, VINNOVA, 2010, p. 24). Public R&D allocations in Sweden include some SEK 200 million for the Östersjö (Baltic Sea) foundation (Growth Analysis, 2011, p. 26). Additional money comes from the EU Structural Funds; more than SEK 2 billion plus national co-funding can be invested in transnational initiatives for regional competitiveness and employment growth. Strengthening knowledge hubs and transferring innovative solutions across borders is a main objective of the EU Baltic Sea Region Programme (Tillväxtverket, 2010a, p. 40).

The Nordic Council has a long-standing history of structural collaboration among Scandinavian countries and actors. Nordic Centres of Excellence are one example. Agencies such as VINNOVA help to organise joint funding activities in different fields. A common Nordic R&D initiative on climate, environment and energy issues has a budget of SEK 500 million for a five-year period.

4.11.3. Internationalisation strategy

Relations between Sweden and the rest of the world are often developed by actors that rely on their own, often joint, strategies rather than on a common government agenda. In contrast, other countries have developed a national internationalisation strategy, including in the area of science, technology and innovation (see Box 4.16). The idea of doing something similar in Sweden has been discussed for some time. Proponents of such an overarching strategy argue that it would provide a more strategic and co-ordinated approach to international co-operation and linkages, and would lead to more consistency and synergy between national and international research and innovation promotion activities. Along these lines, the government might consider developing an explicit internationalisation strategy for R&D and innovation that explicitly sets out orientations and targeted actions. Such a strategy, while providing some "top-down" strategic orientation, should add value to the extensive "bottom-up" international collaboration that already exists between individuals, organisations and businesses.

Box 4.16. The German Internationalisation Strategy

In a world of increasingly globalised science and innovation, countries large and small need to find their place. Germany has addressed this challenge by formulating a comprehensive strategy for the internationalisation of research, from high-level collaboration to support for less well-integrated world regions, and from scientific research to industrial innovation. The strategy takes both inward and outward dimensions into account and has adopted national measures to strengthen the foundations for further internationalisation. The German ministry in charge has adopted a broad, inclusive approach as regards actors and types of collaboration and has worked towards a coherent government policy (BMBF, 2008). The process led to a 2008 government resolution with follow-up activities and reports to parliament (Deutscher Bundestag, 2009), listing the activities of the ministry and various, mainly federal, research and liaison actors. The general public is addressed through ministry reports (BMBF, 2012, pp. 44 *ff.*).

The strategy has four main pillars:

- To enhance research co-operation with the world's best, as even for a large economy like Germany more than 90% of knowledge is created outside the country. Acquiring this knowledge is costly and requires collaboration with actors in different countries. Ambitions for international excellence range from higher education to academic mobility, to the creation of critical mass, to playing an important role in global/multinational infrastructures.
- To open up the international innovation potential. German firms, MNEs as well as the "Mittelstand" and SMEs, have become global actors and inward and outward FDI in R&D is increasing. The German government sees the need to improve framework conditions for inward investment. Funding programmes and targeted activities (such as the High-Tech Strategy) need a strong internationalisation element.
- To strengthen long-term co-operation with developing countries in education, research and development, there is a need to support locally the build-up of foundations for innovation and education, and to help retain local talent. Africa is identified as a hot spot for collaboration.
- To take on international responsibility and overcome global challenges. This pillar concentrates on the grand challenges and on international institutions for organising research and policy action.

While these overall goals or pillars are also found in other countries' internationalisation efforts, the German approach has a number of original characteristics:

- The encompassing nature of the strategy allows for a degree of long-term planning and helps co-ordinate strategies of individual organisations at all levels. It may also help prevent a lack of critical size in some internationalisation activities. It sends a clear signal to partner countries around the globe and helps explain where Germany is heading internationally.
- The strategy includes 15 target indicators (or dimensions) of internationalisation in the four areas mentioned above. Nearly all are quantifiable and many have quantitative goals (Boekholt et al., 2012, p. 32).
- Qualitatively the strategy also addresses national reform processes, e.g. changing governance structures and forms of funding in the higher education sector to raise the attractiveness of German universities as teaching and research locations. In this context, the strategy identifies room for improvement in the German PhD system and its international attractiveness (BMBF, 2008, pp. 8 and 11 *ff.*).
- The strategy process seems to have been accompanied by the provision of additional public funds for internationalisation.
- The mix of ambition and responsibility is balanced. Germany presents itself as a country with much to offer (and much to gain): world-class firms, top universities and well-educated human resources. At the same time it seeks to take on international responsibilities, as regards European research policy, transnational infrastructures, global networks, and support for countries with weak innovation systems.
- The internationalisation strategy is linked to other major German strategies relating to R&D and innovation, including the Excellence Initiative and High Tech-Strategy, but also to foreign policy strategies (BMBF, 2012, p. 44).
- The German strategy addresses the "grand challenges" and the international dimension for tackling them.
- EU research and innovation policy is an important goal that is embedded in larger bilateral, multilateral, regional and global settings. Germany aims to become a motor of European strategy development in RTDI policy (BMBF, 2008, p. 29).

1. A list of activities can be found at *www.bmbf.de/de/13434.php.*

2. See information of the German Parliament, *www.bundestag.de/dokumente/textarchiv/2010/28565330_kw06_sp_wissenschaft/index.html.*

Source: Boekholt, P. *et al*. (2009); BMBF (2008); BMBF (2012); Deutscher Bundestag (2009).

Notes

1 Science policy in Sweden has been traditionally carried out by independent research councils. A predecessor of the Swedish research councils was founded in 1927 by the Royal Swedish Academy of Letters, History and Antiquities, the *Humanistiska fonden* (Fund for Humanities). It was financed in part with funds from the state lottery. In the 1940s, the creation of a series of research councils along American, British and German models established the Swedish science funding structure. These were reorganised in 1977 and again in 2001, when some of the many research councils were grouped into a single council, the Swedish Research Council (VR). VR is still not an all-encompassing organisation, as FORMAS and FAS operate as mission-specific councils.

2 However, in parallel, a number of smaller technical branch research institutes were established through co-operation between industry sectors and the government (Persson, 2008, p. 15).

3 It is interesting to compare Sweden to Switzerland in this regard. The Swiss National Fund (SNF) was created in 1952 as a science funding organisation. It was preceded in 1943 by the Commission for Funding of Scientific Research which also mainly funded university-based projects. Both countries used council funding to address economic challenges. Switzerland put research funding under active labour market policies in difficult times (see Fleury and Joye, 2002). However, Swedish policy focused both on scientific research *via* different councils *and* on applied research through TFR funding, while Switzerland concentrated mainly on the funding of scientific projects and did not finance industry directly.

4 For a general description of STU and sector policies see Herman (1984), Arnold (2008a) and Högselius (2010), pp. 254 ff.

5 Nonetheless, a number of countries base their success on modernised and technologically advanced traditional sectors.

6 *www.sweden.gov.se/sb/d/2067/a/20348*

7 *www.sweden.gov.se/sb/d/2093*

8 It fell from 27.3% of gross budgetary appropriations or outlays for R&D (GBAORD) in 1991 to 7.64% in 2010 (compared to 0% in Austria, 0.4% in Denmark, 2.7% in Finland, 4.4% in Norway or 0.5% in Switzerland).

9 As a recent evaluation (Van der Veen *et al*., 2012) shows, Tekes has a full array of instruments, a central role in the policy-making system and a record of offering complex, integrated funding programmes, with a considerable focus on young companies.

10 Persson (2008, pp. 37 ff.) questions the degree of radical change and proposes to analyse the VINNOVA portfolio as a number of layers from different decades, with some traditional programmes reframed or recoded to fit the new paradigm without

changing the substance. Austria's FFG is in a similar situation but has less ambitious goals and a stronger position in the Austrian system.

11 As VINNOVA's director-general has noted, "For a small country like Sweden to compete globally, many forces must pull in the same direction" (VINNOVA, 2010, p. 5). The term "many forces" includes first and foremost a large number of (more or less similar) public agencies. The rationales and consequences of such ensembles are discussed below.

12 Some EUR 40 million in VINNOVA funding to SMEs compared to more than EUR 100 million for FFG (FFG, Zahlen, Daten, Fakten 2010, 2011, p. 24).

13 According to interviews Swedish peers form the majority, with a growing share of foreign peers. This issue is a matter of concern in smaller countries, even if they have a large population of successful researchers.

14 *www.energimyndigheten.se/en/Research/*

15 *www.snsb.se/en/Home/Swedish-Space-Industry/List-of-Companies/*

16 Clearly most of these challenges can only be answered in an international framework. However a strong country needs its own strategies for what should be prepared for or done on the national level and what it should contribute to a broader effort.

17 A priority area receives SEK 20-80 million a year; only energy research, molecular biology and transport research receive larger sums.

18 In terms of research support, a number of funding initiatives have traditionally helped the automotive sector, spanning from traditional NUTEK/VINNOVA competence centres and VINN centres in fields like combustion, catalysis or road safety to specialised sectoral VINNOVA and STEM programmes. These programmes have recently been strengthened under the heading FFI (*Fordonsstrategisk Forskning och Innovation*). VINNOVA can spend SEK 50 million a year on transport research targeting ecological and safety questions, while STEM has SEK 30 million for e-mobility and alternative propulsion research (GTAI, web source). Finally the automotive industry was massively supported in the aftermath of the 2008 crisis by specific government instruments, *e.g.* Fouriertransform AB received SEK 3 billion in equity for (troubled) firms.

19 This may be partly related to Sweden's industry structure (characterised by the presence of very large corporate actors) and its preferences regarding the tax system.

20 Around a quarter of the funding of the Swedish Energy Agency (Swedish Energy Agency, 2009) goes to industry and the rest to the higher education and PRI sectors. Industry appears again as an important contributor to various programmes and centres.

21 One of many positive side effects of Austria's 45 years of directly supporting industrial (mainly SME) innovations is the high level of know-how in public agencies about the technological and non-technological strengths, weaknesses and linkages of innovative Austrian firms.

22 The introduction of a fiscal incentive scheme involves trade-offs. It may unduly complicate the tax system, carry deadweight losses, and raise problems of controlling appropriate use.

23 For instance, Murray (1998) assessed the European Seed Capital Fund Scheme Under and found that commercially oriented venture funds recorded significantly lower failure rates among investees by comparison with developmentally oriented regional funds. Employment growth per investee, and per fund, was higher in the commercial funds. The pursuit of non-commercial objectives, often involving the targeting of high-risk, low-potential-return and long-maturing investment opportunities, frequently undermines programme sustainability (Bates, 2002).

24 The United Kingdom Innovation Investment Fund (UKIIF) will invest in a small number of specialist private-sector technology funds that have the expertise and track record to invest directly in technology-intensive businesses. The United Kingdom's Department for Business Innovation and Skills, with the Departments of Health, and Energy and Climate Change, are investing GBP 150 million in the UKIIF. Further investment is being sought from private investors in the United Kingdom and abroad with the aim of creating a fund of up to GBP 1 billion over a 12-15 year life.

25 A review of these reforms is provided in the 2011 report of the Swedish Fiscal Policy Council (2011).

26 The report entitled "Creating an Innovative Europe" (the Aho Report) called on governments to "use public procurement to drive demand for innovative goods, while at the same time improving the level of public services", *http://ec.europa.eu/invest-in-research/action/2006_ahogroup_en.htm*.

27 To cite one evaluation: "The success of centres in creating a clear intellectual and cultural identity is quite mixed and remains a challenge for most centres … Attention to organisational development issues will be critical to the success of the Berzelii Centres … The Centre is in many ways not a distinct unit" (Reeve *et al*., 2009, pp. 10 ff., p. 19).

28 Quoted figures are HRST by occupation (HRSTO) as defined in Eurostat (2011).

29 As demonstrated, for instance, by the activities of the Knowledge Foundations or the VINNVÄXT programme.

30 The triple helix approach features prominently in regional policy discourse as a guiding principle for fostering innovation in regions. It is not surprising that this approach was well received. Sweden has had a tradition of collaboration by industry, academia and state agencies, albeit with a more explicit planning dimension. In a way, triple helix arrangements are just a new expression (at the local and regional level) of a *modus operandi* that has existed in Sweden for decades but has come under pressure owing to globalisation, EU accession, privatisation and market forces. The key challenge is to mobilise resources to achieve outcomes that are more than just the sum of the individual parts.

31 ERDF funding is complemented by the European Social Fund (ESF), the second pillar of the Structural Funds, and by 13 cross-border programmes.

32 As an example, the region of North Sweden (Norrbotten and Västerbotten counties) receives a total of SEK 2.2 billion in EU-ERDF funding plus equivalent Swedish co-financing for the following "growth areas": testing, training and security; creative industries and tourism; energy and environment; technologies and services in basic technologies; ICT; biotechnology. In these fields the main emphasis is on entrepreneurship, new business, innovative environments and international co-operation (Tillväxtverket, 2010a, p. 6). Övre Norrland and Mellersta Norrland both have a high share of business innovation funding compared to other kinds of RTDI

funding. Both are among the top 10 European regions in this respect (Rivera Leon *et al*., 2011, p. 35). By contrast the more affluent and densely populated South Sweden region (Skåne and Blekinge counties) is entitled to receive a total of SEK 600 million in EU-ERDF funding plus equivalent Swedish co-financing. Specific technological fields are not mentioned; the main focus is on supporting entrepreneurship and new business, business development and the support of clusters and regional innovation systems. Specific objectives target the accessibility of the region as a hub (IT, transport), the development of the metropolitan area (Tillväxtverket, 2010a, 2008, p. 20) or the clustering of clean technology activities in the region (Tillväxtverket, 2010c, p. 13).

33 *www.socialinnovationeurope.eu.*

34 For Sweden's neighbours such as Latvia or Lithuania, EU funds are nearly twice the national public funds available, with the FPs accounting for a few percent and the Structural Funds by far the biggest source of funding for (public) R&D. Patterns are similar for Estonia and Poland.

35 KICs, with several core centres across Europe, have been established in the ICT, energy and climate fields. The EIT is currently financed outside the FP structure but will be part of Horizon 2020.

36 *www.stint.se/en/stint/*.

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