Effort and Performance of R&D in Sweden

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Introduction

The Nordic countries are, in many respects, global leaders in science, technology and innovation. While each of them displays its specific features, they are all ranked remarkably high in international comparisons of countries' readiness and performance with regard to the so-called knowledge-based economy. As technical progress advances, and rapid improvements in information and communications technology make access to codified information increasingly easy and inexpensive, the ability of countries to develop and make use of knowledge appears increasingly decisive for future well-being.

At the same time, all countries are faced with their challenges how to make the best of the new situation. This includes the Nordic countries, and not least Sweden. Sweden is, in a way, the most extreme of the Nordic countries. While being the leader in the production of scientific articles, in public support of knowledge-generation, overall R&D-intensity in the economy, the registration of patents, etc., when considering its potential, the Swedish economy has for many years appeared to underperform. Viewed over the last three decades, Sweden has lost many positions in comparison to other countries when it comes to overall economic performance. The situation has improved in the last few years, but the basic challenge remains, how can Sweden make full use of its impressive knowledge production?

Approaching such issues requires consideration to the concept of innovation, which in itself needs to be examined within a broader context of several relevant factors. In this study, the concept "innovation system" is used to provide an overview and crude map of the main actors, linkages, and outcomes associated with innovation. Being part of a Nordic collaborative project, co-ordinated for the purpose of generating certain comparable sets of information and conclusions, the study does not provide a full background to all relevant issues. The study rather proceeds to address certain specific aspects viewed as important for understanding key aspects of the system compared to other countries. The reader is referred to other publications, (Freeman, 1987; Lundvall, 1992; Nelson, 1993; Edquist, 1997; Andersson et al., 2002; Andersson et al., 2004), for background on the concepts applied and for coverage of complementary aspects.

The study is initiated by a brief overview of the Swedish innovation system. The national governance set-up is described, followed by a presentation of the main R&D performers, in terms of input and output. The chapter then addresses private and public interaction and its development over time. We go on by describing the labour market for 'knowledge'; how incentives and the effect of the transition to the 'knowledge economy' have changed the Swedish labour market, notably for educated workers. Finally, IT infrastructure and policies are discussed. Conclusions end the chapter.

An Overview of the Swedish Innovation System

Since many years, Sweden has belonged to the countries that invest the most in R&D, applying to both the private and the public sector. R&D is, of course, not the only relevant factor, but merely represents one aspect of knowledge-creating activities and initiatives. Nevertheless, R&D is taken as the point of departure for this presentation, as we start to unravel the input side in regard to knowledge generation within Sweden.

It should be emphasised that R&D is not homogeneous in any way. There are different kinds of R&D, such as basic and applied (although the distinction between the two is far from clear-cut). R&D also relates differently to different kinds of innovation, such as product innovation and process innovation. Here we will highlight another aspect, however, i.e. that the aim and orientation of public and private R&D efforts are very different. Public R&D is mainly conducted in universities and university colleges, and in the defence sector. Private R&D takes place mainly in large multinational companies. The driving forces, and the consequences, of the two kinds vary markedly.

The structure and funding of public R&D[1]

Figure 1 depicts the main institutional actors of the Swedish public R&D system.[2] Lines without arrows show *connections* and arrows show directions of funding. The figures in the boxes represent percentages of the central government R&D budget in 2005, which amounted to 24.6 billion SEK (2.6 billion €). If the percentage figure is in a box where an arrow starts, it shows how large a percentage a certain unit allocates; if it is in a box where the arrow ends, it shows how much the unit receives *in total* (there can be several sources).

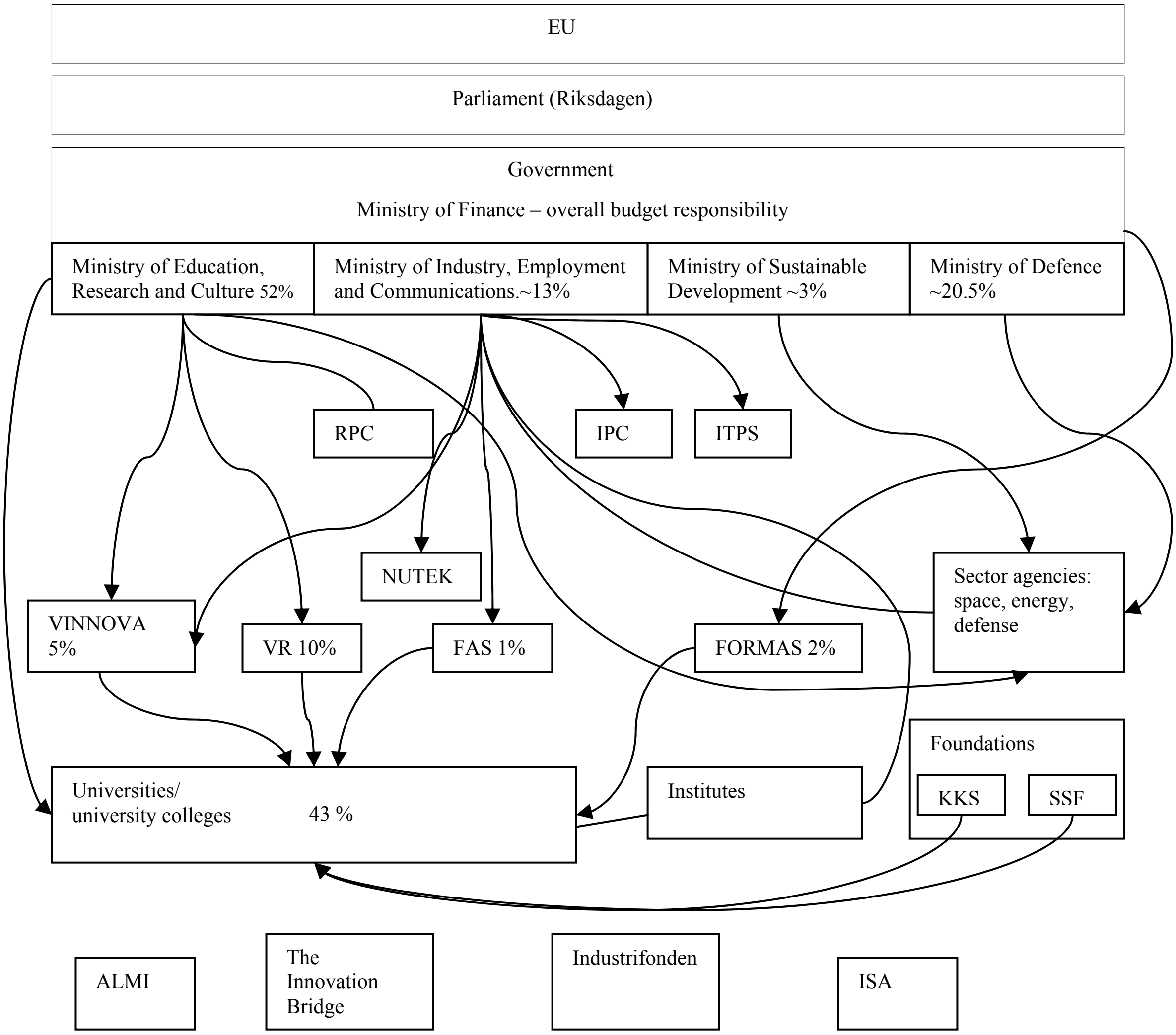
The government level

In most countries, governmental control functions are generally exercised by ministries directly. This is rarely the case in Sweden. Government agencies exercise substantial power and independence. This explains why the ministries are relatively small in Sweden.

In the system of allocating public R&D funds, most public research money comes from the central government, with some additional R&D-activities being financed by counties and municipalities.[3] The most recent distribution of known public funds is reported on in Statistics Sweden (2005c). The most important distributors are: the Ministry of Education, Research and Culture, which allocates 52.3 per cent of public R&D, the Ministry of Defence (20.5 per cent), and the Ministry of Industry, Employment and Communications (12.8 per cent). Other ministries collectively distribute 14.4 per cent.

[1] This section is based in large part on European Commission (2005).
[2] This is a somewhat modified version of Figure 2 in European Commission (2005).
[3] The extent of the latter has been estimated at about 7 billion SEK yearly or roughly 740 million € (European Commission, 2005), but the importance and distribution of these funds have not been thoroughly investigated.

Figure 1. Selection of main public actors in the Swedish innovation system and major flows of public R&D investments. Source: Based on Figure 2 in European Commission (2005).



The main recipients of funding from the Ministry of Education are the universities and university colleges. In addition, the ministry has, together with the Ministry of Industry, the overall responsibility for VINNOVA (see below). The Research Policy Council (RPC), established in 1962, is chaired by the Minister of Education and plays an important role in preparing the research policy bill every fourth year. The Ministry of Defence mainly allocates funds for defence research purposes to technology for Sweden's Security (FMV). The Ministry of Industry has responsibility for labour market issues and working life, the business sector, energy, ICT, communications and infrastructure and regional development. It also governs the Institute for Growth Policy Studies (ITPS - see below). The Minister of Industry chairs the Innovation Policy Council (IPC), which aims to provide a basis for communication between the minister and important stakeholders. IPC gathers representatives from many areas, with the composition shifting depending on what area is being addressed.

Agencies, research councils

Table 1 illustrates the distribution of public funds by recipient. Higher education (universities and university colleges) receives the largest share, 43 per cent, followed by defence, 20 per cent and other authorities, 18 per cent. Three research councils together received a total of 13 per cent of the 2005 R&D budget. These are the Swedish Research Council (VR), Swedish council for working life and social research (FAS), and Swedish Research Council for Environment, Agricultural Sciences and Spatial planning (FORMAS). Grants are rewarded based on peer review application procedures from these. VR, whose purpose is to support basic science, is accountable to the Ministry of Education but also enjoys considerable independence. It has three committees: one for humanities and social sciences, one for medicine and one for natural and engineering sciences. FAS's objective is to promote accumulation of knowledge about working life and the understanding of social processes. Both basic and applied research are supported. FAS is accountable to the Ministry of Industry, Employment and Communications. FORMAS is under the Ministry of Agriculture, Food and Consumer Affairs and the Ministry of Sustainable Development. It supports a wide range of approaches from basic research to more applied efforts.

The tasks of VINNOVA, NUTEK and ITPS are closely related. Part of the old NUTEK, currently the Swedish Agency for Economic and Regional Growth, made up the prime foundation of VINNOVA, the Swedish agency for innovation systems founded in 2001. Meanwhile, ITPS, the Swedish Institute for Growth Policy Studies, was partly composed of units of analysis that used to be part of NUTEK and other related public authorities. Today, the aim of NUTEK is to contribute to more start-ups, enterprise growth, and more competitive regions. This is done through development and dissemination of knowledge especially to entrepreneurs, public support programmes, support for the creation of networks and alliances, and regional support to enterprises. NUTEK reports to the Ministry of Industry. VINNOVA, on the other hand, supports directed and more applied research efforts. Its chief aim is to develop an efficient innovation system. It applies a sectoral approach in several of its activities, encourages co-operation, clustering, the strengthening of regional innovation systems, etc., as instruments to back increased innovativeness in support of growth and societal needs. Some of the priority areas for VINNOVA are the commercialization of new technologies, transportation, and working life. ITPS, also founded in 2001, can be described as a government think-tank (European Commission, 2005). It has responsibility for establishing an evaluation culture, and analyses various issues related to growth and regional development as a way of enhancing the long-term basis for government decision-making. It also conducts analysis on developments in other countries and collects some official statistics, for instance, on foreign investment flows and activities.

Table 1. Public R&D funds from the central government budget in Sweden 2005 by recipient unit. Million Swedish kronor (million €) and per cent of total. Source: Statistics Sweden (2005c).

Item	MSEK	M€	%
Total	24 633	2 612	100
Higher education	10 606	1 125	43
Swedish Research Council	2 523	268	10
FAS	273	29	1
FORMAS	528	56	2
VINNOVA	1 121	119	5
Defence	4 918	522	20
Other authorities	4 352	462	18
Business	89	9	0
Int. organizations	166	18	1
Others	57	6	0

The Swedish national space board reports to the Ministry of Industry. It distributes grants for space research, technology development and remote sensing activities, initiates research and is Sweden's international coordinator in its area of expertise. Research is funded by the Ministry of Education. The purpose of the Swedish Energy Agency (STEM) is to contribute to the transformation of the Swedish energy system into an ecologically and environmentally sustainable one. This is done by guiding state capital to the area of energy in collaboration with industry, trade, energy companies, municipalities, and the research community. Technology for Sweden's Security (FMV) has roughly 2,000 employees. Its role is to support and procure development of advanced defence materiel. Research is ordered from industry, institutes, and the university sector. Invest in Sweden Agency (ISA) has the role of assisting and informing foreign investors about business opportunities in Sweden.

Foundations and industrial research institutes

There are presently six semi-public foundations that support research of strategic importance. Each is directed by a government-appointed board, but beyond this public control is limited. For instance, direction of R&D is not under government control. The six controlled altogether some 167 million € in 2005. The two foundations with the largest R&D budgets, about 70 per cent of all foundations' R&D investments, are the Knowledge Foundation (KKS) and the Swedish Foundation for Strategic Research (SSF), (European Commission, 2005). KKS supports research at universities and university colleges, supports competence development in business life, fosters ICT use in schools, education and the healthcare sector and restructuring of industrial research institutes. SSF supports research in natural science, engineering and medicine.

The industrial research institutes are much smaller than in many other countries. Their research is about 3 per cent of the public R&D budget. Their role is to bridge the gap between academia and business communities by ensuring that companies can apply research results and that experience and hands-on problems are addressed by research. KKS works with the Ministry of Industry to reduce these problems and works closely with universities and university colleges. This is done mainly through Ireco, a holding company of which KKS owns 45 per cent and the Ministry of Industry 55 per cent. Most industrial research institutes are now privately owned.

While restructuring work has been ongoing since 1997, a major effort to consolidate and sharpen the operations of the industrial institutes has commenced only as of 2005. The reform under way involves a merger of various institutes, an increased capital basis, and also a strengthening of government ownership and control. For some institutes there is a concern for increased top-down control and reduced bottom-up sensitivity to meet industrial needs.

The universities/university colleges

In the Swedish higher education system there are two main types of education and research institutions: Universities (U) and University Colleges (UC) (högskolor). There are also the so-called "Folk High Schools" (folkhögskolor)[4], but their role consists mainly of providing non-theoretical education, and they have limited roles as research units.

The difference between the universities and the university colleges is no longer as clear-cut as it used to be. Traditionally, the distinction between the two meant that the universities conducted research and had the right to provide postgraduate education. University colleges can now also provide postgraduate education, but they have to apply for the right to do so for: a) specific subjects (such as economics, German language, theoretical physics etc), or b) science areas (humanities, social sciences…). Nonetheless, universities usually retain a broader profile with most faculties represented. On the other

[4] The first Folk High Schools in Sweden were established in 1868 and today there are 148 Folk High Schools all over the country. 104 of them are run by various popular movements, organisations and associations (NGO's), whilst the remaining 44 are run by county councils or regions. (Folkhögskolornas Informationstjänst, 2005)

hand, because of sharpening competition and requirements for excellence, there is now a general pressure from the government on both universities and university colleges to prioritise, specialise and cooperate with other institutions. However, government legal requirements (högskoleförordningen), for deciding budget allocations, etc., in practice limit the universities' ability to carve out their niches, and continue to favour a mainstream approach. Only a few universities operate outside the mainstream regulatory framework and are allowed greater freedom to manoeuvre.

Sweden has undergone a substantial expansion in higher education during the last decade (see the section on Provision of human capital from higher education). This expansion took place mainly among regional university colleges. The National Agency for Higher Education (2005) reports the existence of 14 state owned universities and 22 state-owned university colleges for higher education. There are also three university colleges (Chalmers University of Technology, Stockholm School of Economics and Jönköping University) that are not owned by the state but by foundations not abiding by the usual government regulations, with the right to conduct research and that can therefore offer doctoral education; another 10 university colleges with examination rights in undergraduate education and some additional education providers only in psycho-analytics. The university colleges do not always, and are not always allowed to, do research. They are usually smaller and do not embody all faculties. Table 2 lists these institutions, reports on the present line-up of faculties and the development of the number of R&D man-years (full-time equivalents) in research 1995-2001.

Table 2. R&D man-years (full-time equivalents) in public universities and university colleges with examination rights in post-graduate education, man-years 1995-2001. Source: Data from Statistics Sweden (2005a) and own additions.

University /college/	City of activity	Main faculty (General = all faculties represented)	1995	1997	1999	2001
Uppsala university	Uppsala	General	2 220	2 375	2 192	2 314
Lund university	Lund	General	2 558	2 733	2 749	2 738
Göteborg university	Göteborg	General	1 791	2 015	1 863	1 794
Stockholm university	Stockholm	General, not medicine, not technical	1 681	1 662	1 695	1 706
Umeå university	Umeå	General	1 128	1 112	1 273	1 327
Linköping university	Linköping	General	890	1 079	1 049	1 108
Karolinska institutet	Stockholm	Medicine	1 581	1 469	1 888	1 882
Royal Institute of Technology	Stockholm	Technical	1 258	1 474	1 675	1 452
Luleå university of technology	Luleå		356	308	443	437
Swedish university of agricultural sciences	Uppsala, Alnarp (Lund), Umeå	Agriculture/forestry	1 798	1 658	1 486	1 403
Chalmers university of technology	Göteborg	Technical	909	938	1 047	1 194
Stockholm school of economics	Stockholm	Business	187	159	156	135
Jönköping university	Jönköping	Technical, business, health, teaching	36	44	69	95
The university of Kalmar	Kalmar	General	0	0	48	107
Blekinge institute of technology	Karlskrona, Ronneby	Technical, business	0	0	83	92
Karlstad university	Karlstad	General	0	0	157	248
Växjö university	Växjö	General	0	0	108	167
Örebro university	Örebro	General	0	0	104	199
Malmö university	Malmö	General	0	0	125	175
Mittuniversitetet	Härnösand, Sundsvall, Östersund and Örnsköldsvik	General	0	0	0	0
Mälardalen university	Eskilstuna, Västerås	General	0	0	0	0

Detailed sources of finance in higher education in social sciences and natural and technical sciences are shown in Table 3 and Table 4. These tables show that total sources have increased by nearly 50 per cent between 1995-2001 in social sciences, but by only 26.5 per cent in natural and technical sciences. Natural and technical sciences, however, obtain more than four times larger resources than social sciences. Between 1995 and 2001, the number of students has increased in higher education, especially in the earlier part of this period. Major sources of financing are faculty grants, research councils, government authorities, and the private non-profit sector in social sciences. In natural and technical sciences, faculty grants, government non-faculty grants, research councils, government authorities and the private non-profit sector are important contributors. Social sciences are relatively more dependent on faculty grants, whereas sources of funding come from a more diverse set of sources for natural and technical sciences. 1995-2001 seems to have been a turbulent period in terms of the distribution of sources. Faculty grants are becoming less important for both social sciences and N&T sciences; although in absolute terms the amounts are rising. Research councils have become less important financiers between 1995 and 2001, which is a reflection of the problems of the stock market in the early 2000s. Swedish companies are relatively unimportant (albeit increasing their share) as a source of finance in social sciences, but account for nearly 7 per cent of funding in natural and technical sciences. The private non-profit sector has become a quite important funding source for both groups of sciences. Foreign companies are relatively unimportant as sources of finance, even though their share has increased almost threefold in N&T sciences.

Table 3. Sources of finance in social sciences in Sweden 1995 and 2001: million Swedish kronor, in per cent of total, and percentage increase. Source: Statistics Sweden (2005a) and own calculations.

Item	1995	2001	1995	2001	% increase 1995-2001
Faculty grants	1 085	1 432	53.9%	48.2%	32.0%
Government but not faculty grants	111	161	5.5%	5.4%	45.0%
Research councils	232	172	11.5%	5.8%	-25.9%
Own foundations and funds including financial net receipts	37	53	1.8%	1.8%	43.2%
Government authorities	330	506	16.4%	17.0%	53.3%
Municipalities and county councils	47	58	2.3%	2.0%	23.4%
Swedish companies	42	51	2.1%	1.7%	21.4%
Private non-profit sector in Sweden	83	288	4.1%	9.7%	247.0%
Foundations with capital from previous employee funds	4	158	0.2%	5.3%	3 850.0%
EU	8	34	0.4%	1.1%	325.0%
Foreign companies	4	8	0.2%	0.3%	100.0%
Private non-profit sector abroad	9	12	0.4%	0.4%	33.3%
Other financial sources	21	40	1.0%	1.3%	90.5%
Sum	2 013	2 973	100.0%	100.0%	47.7%

Table 4. Sources of finance in natural and technical sciences in Sweden 1995 and 2001: million Swedish kronor, in per cent of total, and percentage increase. Source: Statistics Sweden (2005a) and own calculations.

Item	1995	2001	1995	2001	% increase 1995-2001
Faculty grants	4 224	4 609	42.0%	36.2%	9.1%
Government but not faculty grants	1 110	1 111	11.0%	8.7%	0.1%
Research councils	1 319	1 032	13.1%	8.1%	-21.8%
Own foundations and funds including financial net receipts	333	168	3.3%	1.3%	-49.5%
Government authorities	1 212	1 654	12.1%	13.0%	36.5%
Municipalities and county councils	123	290	1.2%	2.3%	135.8%
Swedish companies	526	841	5.2%	6.6%	59.9%
Private non-profit sector in Sweden	598	1 297	5.9%	10.2%	116.9%
Foundations with capital from previous employee funds	51	813	0.5%	6.4%	1 494.1%
EU	122	368	1.2%	2.9%	201.6%
Foreign companies	77	261	0.8%	2.1%	239.0%
Private non-profit sector abroad	108	131	1.1%	1.0%	21.3%
Other financial sources	252	147	2.5%	1.2%	-41.7%
Sum	10 055	12 722	100.0%	100.0%	26.5%

Regional actors

One recent survey identified altogether 405 actors and associations as engaged in promoting early stages of innovation in Sweden (Sjögren and Rosenberg, 2004). To provide some further information, apart from NUTEK, the following actors play an important role for promoting entrepreneurship and providing seed capital: ALMI business partner, Industrifonden and the Innovation Bridge.

ALMI, which was set up in 1994 is present in all the 21 counties of Sweden. Investments are open to high-risk ventures and are made in start-up phases as well as in later development phases. Financing is supposed to complement the private market.

Industrifonden works more like a private venture capitalist; it is important to make profit. It invests in small- and medium-size companies shortly after the start-up and/or in expansion phases.

The Innovation Bridge (Innovationsbron AB) is a new group started in March 2005 based on the former technology bridge foundations. The technology bridge foundations were founded in 1994 for the purpose of strengthening knowledge flows between academia and business. The Innovation Bridge will have offices in seven towns. It will provide venture capital to businesses in the early stages, amounting to 1,800 MSEK (190 M€) over 10 years. Funding comes from VINNOVA, Industrifonden, and the technology bridge foundations. The last group presently operates as regional foundations with the aim to improve knowledge transfer and cooperation between universities and business, but these foundations are to be dissolved by the end of 2007.

A new research bill – additional funds 2005-2008[5]

A research bill addressing the period 2005-2008 was made public in March 2005. The new bill "stresses the importance of prioritizing among current research fields and pooling together available resources in order to achieve synergies and greater impact." (European Commission, 2005, p. 42).

An extra 2,340 MSEK (248 M€) is put to extra use:

- *Research* gets an additional 981 MSEK (104 M€). Prioritized areas are: life science, 400 MSEK (42 M€), engineering, 350 MSEK (37 M€) and sustainable development, 210 MSEK (22 M€).
- *Researchers of the future* is an area that aims at "securing good supply of researchers" (ibid, p. 43) and "making it more attractive to become a researcher" (ibid). There are three measures to support this. Postdoc positions are given 521 MSEK (55 M€), grants directed to young researchers are given 150 MSEK (16 M€). Development of multidisciplinary knowledge is given 100 MSEK (11 M€) through graduate schools.
- *Strong research environments (Centres of excellence)* are given 300 MSEK (32 M€). This aims at "the creation and improvement of centres of excellence" (ibid) to obtain critical mass in research fields characterized by high levels of specialization.
- *Knowledge transfer*. 300 MSEK (32 M€) is given to measures that will improve knowledge transfer between universities, business and the rest of society. It consists of four parts: 120 MSEK (13 M€) to private-public partnerships in automotive, environment technology, air and space sectors). These partnership funds have to be matched by equal amounts from industry. 10 MSEK will be used improve SMEs' access to research. In addition, universities are to establish "action plans for commercialization" (ibid).
- *Infrastructure for research*. 42 MSEK (4.5 M€) is given to costly scientific equipment and 30 MSEK (3 M€) to transformation of material from the Swedish National Archive of Recorded Sound and Moving Images (SBLA) to new technology and a permanent research school in design.

Funding of private R&D

Table 5 displays the sources of R&D funding in the business sector. Total spending increased significantly between 1997 and 2003, although the table masks a downturn from 2001 to 2003, mainly related to a drop in R&D spending by Ericsson and Sony-Ericsson. It is still too early to tell whether this drop marks the start of a stagnation in Swedish R&D spending, which has increased ever since 1989, not only in absolute numbers but also as a share of GDP. The most important source of finance is own funds, representing a virtually unchanged proportion of funding sources (about 80 per cent during the period). Military authorities, which used to play a prominent role for Swedish business life, represent a diminishing source of R&D budgets. The same can be said for other sources of government funds. Even though EU framework and non-framework programmes represent increasing sources of R&D funding, their contribution is still miniscule. Another increasingly important source of funding are foundations with capital from previous employee funds, but they are limited in relative terms. Private R&D funding originates to an increasing degree from non-public sources. Instead, sources are more frequently found within the enterprise group, both Swedish-owned firms and foreign-owned affiliates, and also from international joint ventures.

An interesting issue which is currently looked at, e.g. by ITPS, is whether the acquisition of Swedish headquarters by foreign-owned firms brings a subsequent reduction in R&D in the Swedish unit.

[5] The material in this section builds exclusively on European Commission (2005).

Another one is whether investment in R&D by Swedish-owned multinationals abroad substitutes for R&D at home. On both these two issues, it so far appears that restructuring caused by internationalization has led to a further strengthening of R&D in Sweden. On the other hand, there is also the possibility that transfer pricing and bookkeeping practices lead to a certain exaggeration of R&D (and also value added) reported by Swedish industry. The extent of this is also being studied by ITPS.

Table 5. Sources of R&D funding among Swedish enterprises. Million Swedish kronor 1997 and 2003 and per cent of total. Sources: Statistics Sweden (2005a).

Item	1997	2003	1997	2003
Own funds	39 912	57 922	80.2%	80.5%
Government civil funds	78	0	0.2%	0.0%
Military authorities	3 028	3 207	6.1%	4.5%
Authorities excl. military	706	607	1.4%	0.8%
Swedish enterprises within enterprise group	665	2 057	1.3%	2.9%
Joint ventures and other industry groups in Sweden	3 710	1 698	7.5%	2.4%
Foundations with capital from previous employee funds	38	540	0.1%	0.8%
Branch organizations	165	119	0.3%	0.2%
EU framework programmes	124	225	0.2%	0.3%
EU, excl. framework programmes	36	269	0.1%	0.4%
Foreign sources outside own enterprise group	236	2 031	0.5%	2.8%
Foreign affiliates within own enterprise group	1 078	3 273	2.2%	4.5%
Total	49 776	71 948	100.0%	100.0%

Private and public partnership in innovation

Table 6 shows the sources of information for innovation in Swedish companies from the third Community Innovation Survey from 1998-2000 among manufacture and service industries, and divided by size classes. Larger firms, quite naturally, seek inspiration inwards as a result of their having more internal resources and hence this type of resource tends to be more important. There is no visible difference here for industry vis-à-vis services. Other companies within the industry group are more important for firms of intermediate size (100-249 employees) than for the small firms (20-49 employees), but for the largest firms this is not as important, perhaps because there may not be so many other companies of comparable size in that group and that relevant resources are internalized. The importance of suppliers and customers does not vary much by firm size, but customers seem to be relatively more important among service branches. Furthermore, competitors are much more important sources of information for service sectors, as is higher education. The importance of higher education seems to be related to size. For firms with 100-249 employees, higher education is markedly more important, which can also be said about firms with 500 or more employees, although for the category 250-499 employees it is not as important. Research institutes are relatively important for the 100-249 employees category and the 500 or more category. Conferences only seem to be quite important for the really large firms (500 and up), whereas exhibitions are only relatively important among firms in the 250-499 category. It is quite surprising how little importance is attached to the higher education sector as a source of information. Compared for instance with research institutes; more than half the importance of the HE sector as a source of information for innovation emanates from the institute sector, despite the fact that their means for research correspond only to 3 per cent of the public R&D budget.

Table 6. Information sources for Innovation in Swedish companies 1998-2000. Source: Statistics Sweden (2005a).

Size class/branch	Within the own company	Other companies within industry group	Suppliers	Customers	Competitors	Higher Education Sector	Research institutes	Conferences	Exhibits
Total	**52% ± 5%**	**27% ± 6%**	**22% ± 4%**	**50% ± 5%**	**11% ± 3%**	**7% ± 2%**	**3% ± 1%**	**3% ± 1%**	**7% ± 3%**
Size class									
10-19 employees	48% ± 8%	.. ± ..	24% ± 7%	51% ± 8%	6% ± 5%	5% ± 4%	2% ± 2%	2% ± 2%	8% ± 5%
20-49 employees	54% ± 9%	16% ± 9%	23% ± 8%	52% ± 9%	14% ± 8%	4% ± 4%	0% ± 0%	2% ± 1%	7% ± 5%
50-99 employees	.. ± ..	.. ± ..	.. ± ..	.. ± ..	.. ± ..	6% ± 4%	3% ± 3%	7% ± 8%	5% ± 3%
100-249 employees	52% ± 8%	40% ± 9%	16% ± 7%	42% ± 9%	11% ± 5%	21% ± 3%	19% ± 3%	2% ± 3%	5% ± 3%
250-499 employees	57% ± 6%	34% ± 7%	16% ± 5%	48% ± 6%	9% ± 4%	7% ± 3%	2% ± 1%	8% ± 3%	10% ± 4%
500-	70% ± 5%	29% ± 7%	20% ± 5%	54% ± 7%	14% ± 4%	14% ± 5%	10% ± 4%	12% ± 4%	4% ± 3%
Branch									
Industries									
SNI[6] 10-41	**51% ± 4%**	**16% ± 4%**	**21% ± 4%**	**44% ± 4%**	**8% ± 2%**	**4% ± 2%**	**2% ± 1%**	**4% ± 1%**	**7% ± 2%**
Service sectors									
SNI 51-74.3	**51% ± 9%**	**.. ± ..**	**24% ± 8%**	**58% ± 9%**	**16% ± 7%**	**9% ± 4%**	**5% ± 2%**	**3% ± 2%**	**8% ± 5%**

[6] Svensk näringsgrensindelning – the Swedish Standard Industrial Classification. See http://unstats.un.org/unsd/cr/ctryreg/ctrydetail.asp?id=258

Incubators and Science parks

Since May 2003, VINNOVA operates a seven-ten year long programme to support selected incubators (European Commission (2004)). 14 incubators were given priority based on "business criteria as experience, access to business angels, ownership, and incentive for the management team, and support by the local university" (European Commission (2004, pp. 22-23)). The programme pays up to 50 per cent of matching funds of a grant. The annual budget is € 4.5 million, with € 17.7 million in matching funds.

An effort has been made by ITPS (2004) to map the actors of the Swedish innovation system. In Appendix 3 there is a list of these actors. The categories include, among others (own translation): "Higher education related actors" (55 actors), "Holding companies" (9 actors), "Technology parks" (33 actors), among which we find science parks and incubators, and "Technology bridge foundations" (7 actors). There are also numerous actors in other categories. As mentioned before, a new group, The Innovation Bridge, has recently been formed. This group has taken over VINNOVA's incubator programme.

Liberalization, integration with world markets

Today, Swedish policy continues towards liberalization, albeit at a slower rate than before. Major deregulations and/or reforms in the direction of market liberalization were undertaken in the early 1990s, notably in housing, electricity, and telecommunications. Integration with world markets in financial markets, energy and telecommunications among other areas, also followed the general pattern among advanced economies, and was closely related to the integration process of the European Union.

Table 7 illustrates the trends in state control, barriers to trade and investment, and barriers to entrepreneurship among OECD countries. Sweden has little state control of enterprises, although it does not belong to the group of countries with the least control. There are few barriers to trade and investment, and low barriers to entrepreneurship. Despite this, few new enterprises are started. Sweden scores among the lowest among 40 countries and is consistently, though barely, beaten by all the other Nordic countries as reported by the Global Entrepreneurship Monitor (2005) and other available indices that attempt to measure incidence of entrepreneurial activity.

Figure 2 and Figure 3 on trade integration in goods and services respectively, show that there is great variation in the degree to which countries trade with the outside world. Trade integration is measured as the average of exports and imports, divided by GDP. Naturally, this is a reflection of country size.[7] All Nordic countries have a trade integration rate of around 30 per cent in goods. These figures show the importance of world markets for Sweden. Despite being the largest of the Nordic countries, it has nonetheless the highest integration rate. The historical past with an industry structure consisting to a large extent of exporting firms is thus confirmed. All Nordic countries (as well as EU-15) displayed rising integration rates from 1996 to 2000 but somewhat lower levels of integration in 2004. Growth in international trade among EU countries seems to have slowed between 2000 and 2004. Moreover, this decline is particularly marked among the Nordic countries. The reason is probably in part that Nordic countries grew faster than EU countries, so that there was smaller scope for growth in trade relative to growth in domestic exchange of goods. In trade integration of services, Denmark, Iceland and Norway are leading among the Nordic countries. Sweden and Finland are clearly behind, most likely because of historical roots combined with regulatory conditions. Trade integration has been rising substantially for Denmark, Norway and Sweden, while service integration in Finland may have stagnated.

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[7] The reason for the relatively lower integration rates for EU as a whole rests of course in the large extent of intra-community trade, rather than with the outside world.

Table 7. Index of State control, barriers to trade and investment, and barriers to entrepreneurship. Source: OECD (2005b).

Country	State control		Barriers to trade and investment		Barriers to entrepreneurship	
	1998	2003	1998	2003	1998	2003
Australia	1.4	0.6	1.0	0.9	1.4	1.1
Austria	2.5	1.9	1.3	0.7	1.7	1.6
Belgium	3.3	2.4	1.1	0.3	1.9	1.6
Canada	1.8	1.7	1.3	1.1	1.0	0.8
Czech republic	3.9	2.5	3.1	0.9	2.0	1.9
Denmark	2.2	1.3	0.9	0.8	1.4	1.2
Finland	3.3	2.3	1.1	0.6	2.1	1.1
France	3.3	2.7	1.5	1.0	2.8	1.6
Germany	2.9	2.2	0.9	0.6	2.0	1.6
Greece	4.5	2.8	1.9	1.2	2.1	1.6
Hungary	3.9	3.3	1.9	1.4	1.6	1.4
Iceland	2.1	1.1	1.0	0.3	1.8	1.6
Ireland	2.6	2.0	0.8	0.5	1.2	0.9
Italy	4.4	3.2	1.5	1.1	2.7	1.4
Japan	1.9	1.5	1.3	0.9	2.4	1.4
Korea	2.7	1.7	2.2	1.3	2.5	1.7
Luxembourg	-	2.0	-	0.7	-	1.2
Mexico	2.5	1.9	2.1	2.4	2.7	2.2
Netherlands	2.7	1.9	0.9	0.7	1.9	1.6
New Zealand	1.5	1.4	1.6	0.8	1.2	1.2
Norway	3.2	2.8	1.0	0.8	1.5	1.0
Poland	4.6	3.6	4.3	2.4	2.8	2.3
Portugal	3.7	2.7	1.1	0.8	1.8	1.3
Slovak Republic	-	1.4	-	1.6	-	1.2
Spain	3.2	2.7	1.6	0.7	2.3	1.6
Sweden	**2.2**	**1.9**	**1.4**	**0.8**	**1.9**	**1.1**
Switzerland	2.8	2.2	1.7	1.0	2.3	1.9
Turkey	3.9	2.8	2.3	1.7	3.2	2.5
United Kingdom	1.8	1.7	0.6	0.4	1.1	0.8
United States	1.4	1.2	1.1	0.7	1.5	1.2

Figure 2. Trade integration of goods among EU-15, EU-25, Nordic countries and major EU-economies. 1996, 2000 and 2004. Source: Eurostat (2005).

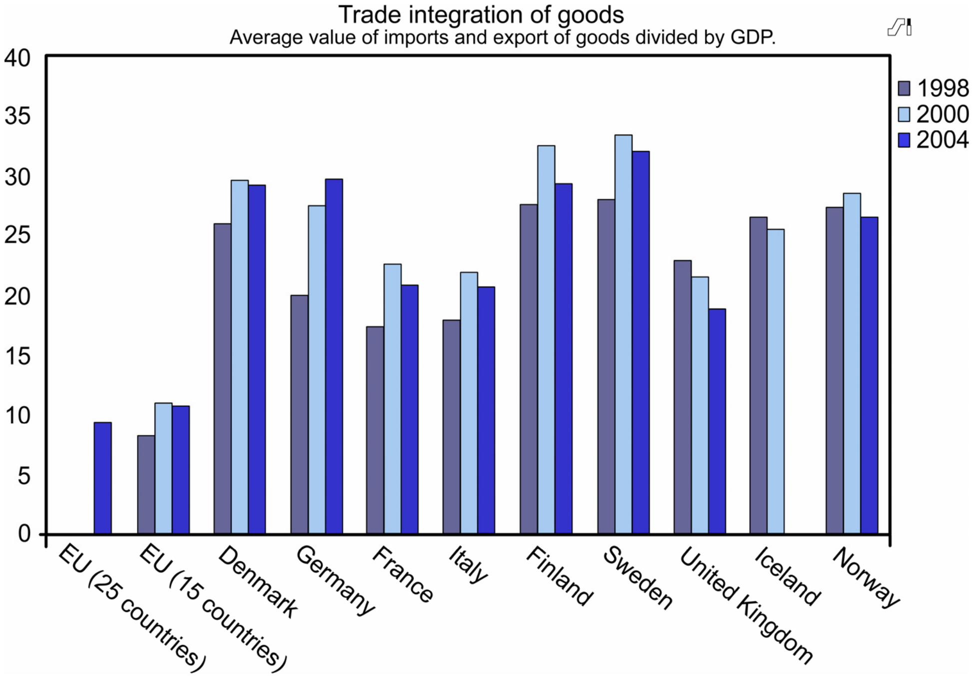
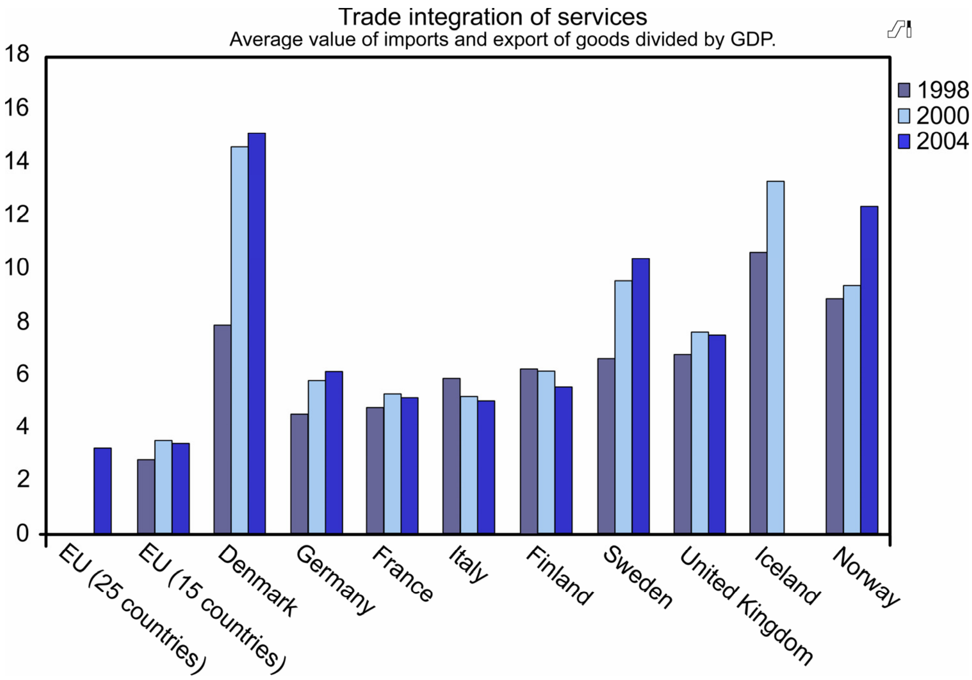


Figure 3. Trade integration of services among EU-15, EU-25, Nordic countries and major EU-economies. 1996, 2000, and 2004. Source: Eurostat (2005).



R&D-investments and resources

R&D is increasingly viewed as strategically important for long-term competitiveness. Often, countries are compared on the basis of expenditures, and raising R&D expenditures in the EU to the levels prevailing among the prime competitors (the US and Japan) has been portrayed as an important target for European competitiveness policy. We view this indicator as somewhat misleading, however, since it is purely an input-indicator. In the following, we rather review human resources in the area.

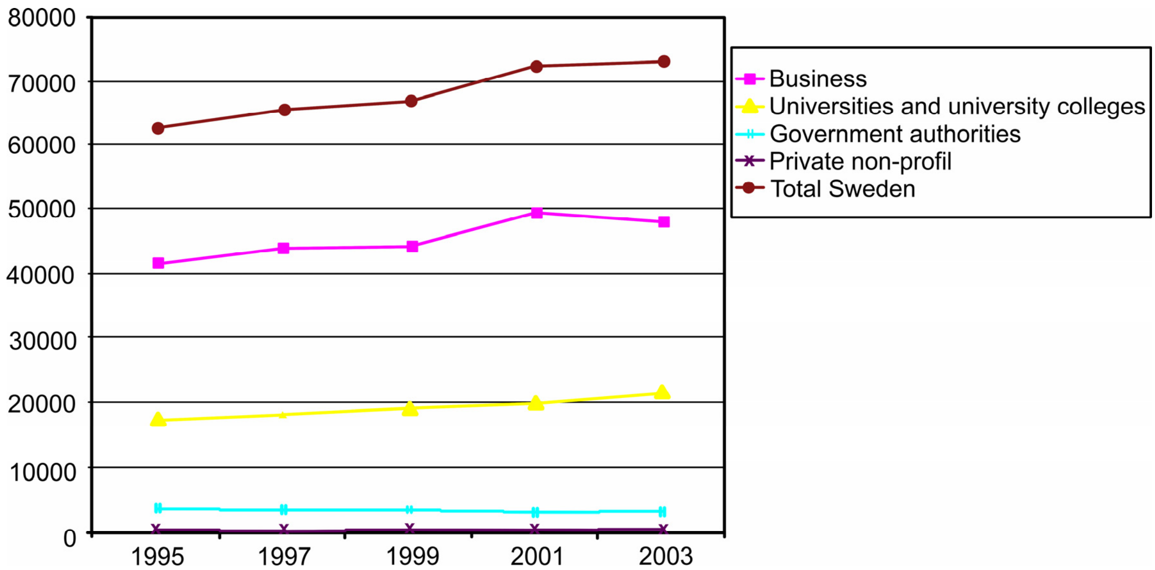
Table 8 provides an overview of R&D staff indicators for Sweden in international comparison. These figures show that Sweden has a high number of R&D employees compared with both the OECD and EU-averages. The difference rests mainly in the business sector where Sweden has more than double the average of OECD and EU countries in terms of R&D personnel per thousand employees in industry. The number of higher education (HE) researchers as a share of the national total is roughly around the average for OECD and EU countries (last item). Figure 4 shows the distribution of total Swedish R&D man-year across sectors.

Table 8. Researchers and R&D staff in Sweden, OECD, EU-15, and EU-25, 1999 and 2001. Source: OECD (2004a).

Item	Sweden 1999	Sweden 2001	OECD 1999	EU-15 1999	EU-15 2001	EU-25 1999	EU-25 2001
Total researchers per thousand total employment	9.6	10.6	6.4	5.6	5.9	5.3	5.6
Total R&D personnel per thousand labour force	15.2	16.2	..	9.9	10.4	9.1	9.5
Business Enterprise researchers per thousand industrial employment	9*	10.5*	5.7	4	4.3	3.5	3.8
Total Business Enterprise R&D personnel per thousand employment in industry	17.4	18.5	..	8.1	8.4	7.1	7.3
HE researchers as a percentage of national total	36.6	34.5	26.4	34.3	35.3	36.3	37.2

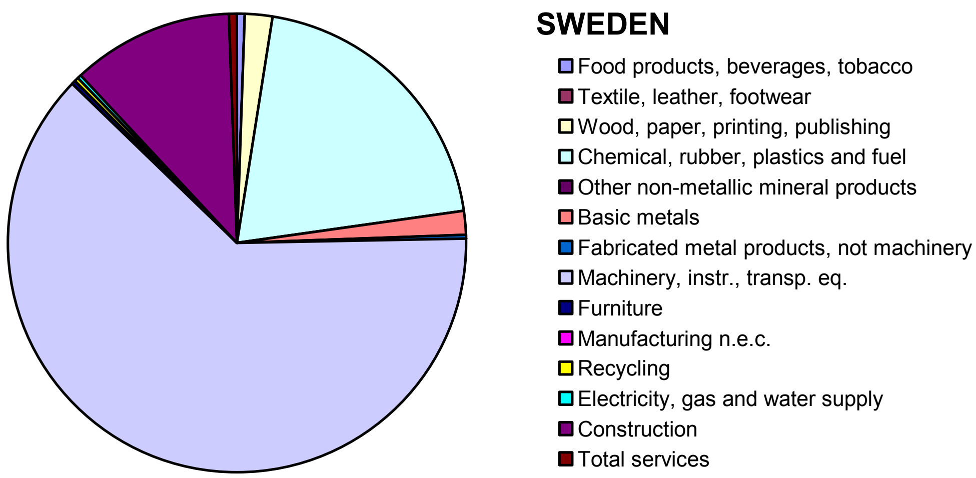
* University graduates instead of researchers. All figures are OECD secretariat estimates or projections based on national sources.

Figure 4. R&D man-years in Sweden 1995-2003 by sector. Source: Statistics Sweden (2005a).



The distribution of business R&D in Sweden and OECD-19[8] across industries for 2001 is shown in Figure 5. Machinery and equipment, instruments, and transport equipment is the predominant group of industries for R&D in both Swedish and OECD-19. Much of Swedish R&D here takes place in radio, television, and communications equipment, dominated by Ericsson and Sony-Ericsson. In fact, relatively large companies are responsible for most of Swedish R&D. One area where Sweden has relatively more R&D than OECD-19 is "Chemical, rubber, plastics and fuel", where pharmaceutical R&D resides. Here, AstraZeneca is an important contributor to Swedish R&D.

Figure 5. Distribution of Swedish and OECD-19 R&D expenditures in 2001. Source: OECD STAN database.



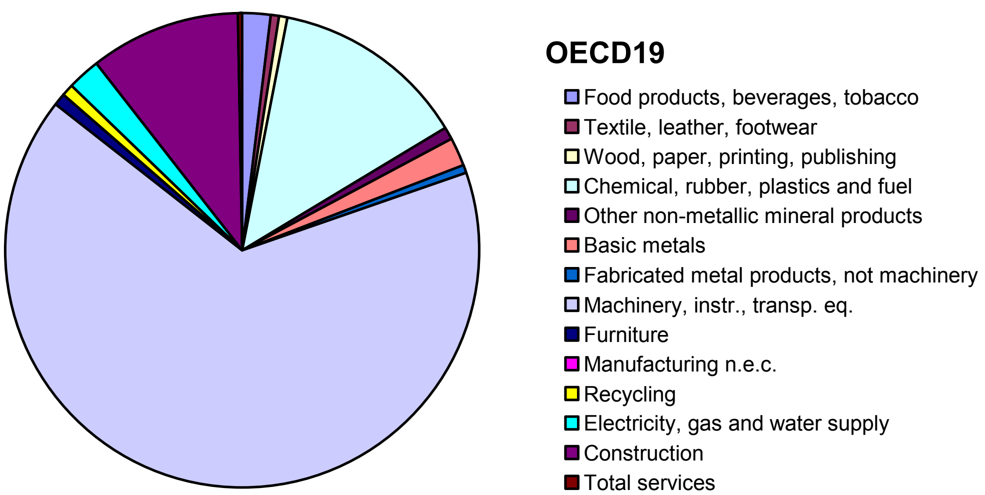


Table 9, reproduced from Ejermo (2004), gives a flavour of the dominance of large Swedish R&D firms, and shows that they were founded early on. All the companies have substantial R&D in Sweden. The table shows that these companies also have a very large share of their total employment abroad. In fact, this no doubt represents one of today's challenges for the Swedish innovation system: R&D is performed domestically in corporate labs, mainly in multinationals,

[8] The countries in this group are: Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Korea, Netherlands, Norway, Poland, Spain, Sweden, United Kingdom, and United States.

whereas employment expansion occurs abroad, closer to larger markets. The foreign expansion of these firms is a major factor enabling them to pursue significant R&D, but the payoff in terms of increased growth is now increasingly also taking place abroad. Foreign and domestic expansion used to be complementary, but substitution effects are now prevalent as well (Andersson, 1998, 2005; Svensson, 1996).

Table 9. Swedish multinational companies built on a major invention.[1] Source: Ejermo (2004).

Company (founding year)	Invention (year)	No. of employees globally[2]
AGA (1909)	Aga, a gas storage system (1906)	9 821
Alfa Laval (1883)[3]	The continuous (cream) separator (1878)	9 125
Asea (1883, 1890)	The triple phase electrical system (1879)	139 051[4]
Atlas Copco (1873)	Pneumatic hammers (1901)	25 787
Electrolux (1901)	Vacuum cleaner (1915)	81 971
Ericsson (1876, 1918)	Automatic telephone switchboard (1886)	73 420
Nitroglycerin Compagniet (1865)[4]	Dynamite (1867)	4 300
Sandvik (1862)	Ingot steel production (1862)	37 388
SKF (1907)	The self-aligning ball bearing (1907)	39 739
Tetra Pak (1951)	Packaging system for liquid food products (1945)	20 900

1. Sources: Founding year from Affärsdata or company web pages. Employee data are from Annual reports. Data on inventions from web pages and Sedig (2002).
2. All employment data are from 2002 except for AGA, which merged with the Linde group in 1999. Their employment data are from before the merger.
3. Alfa Laval is part of the Tetra Pak group since 1991.
4. Employment data is for the whole of ABB, the group that came out of the merger between Swedish Asea and Swiss Brown Boveri.in 1988. Before the merger Asea employed 71 000; Brown Boveri 97 000.
4. Nitroglycerin Compagniet today operates under the name Dyno Nobel with its headquarters in Norway.

Table 10 shows that the number of science and engineering graduates increased drastically in recent years. From having lagged substantially behind in terms of the number of graduates, Sweden has now surpassed EU-15 and ranks as the 6th country in terms of its share of graduates among the population. A large share of the Swedish working population has attained tertiary education: roughly 27 per cent according to the latest figures. This share is higher than for EU-15 and EU-25. Sweden ranks as the leading country in the area of lifelong learning. Lifelong learning is more than three times the average of EU-15 and EU-25. However, the European Trend Chart on Innovation (2005) expresses doubt about the relevance of this figure for Sweden, since part of this learning is not directly relevant to innovation, and many "general" courses are included in the concept. Employment in hi-tech manufacturing has dropped somewhat but now seems to be stable at around the EU-15 average. On the other hand, employment in hi-tech services is substantially higher than the EU-average: Sweden has the highest share of all EU-25 countries.

Table 10. Human capital resources and employment in hi-tech industries in Sweden. Source: European Commission (2005).

Item	1998	1999	2000	2001	2002	2003	Latest (EU-25 =100)	Rank among EU-25	Current (1)	Trend (2)
S&E graduates	7.9	9.7	11.6	12.4	13.3	--	116	6	0	+
relative to EU-15	74	87	102	100	107	--				
Work pop. tertiary education	27.6	28.5	29.7	25.5	26.4	27.2	129	7	+	0
relative to EU-15	160	139	140	119	121	--				
Lifelong learning	--	25.8	21.6	17.5	18.4	34.2	380	1	++	
relative to EU-15	--	315	254	208	216	353				
Employment hi-tech manufacturing	8.63	8.26	7.90	7.72	7.27	7.03	107	8	0	0
relative to EU-15	112	108	104	102	99	99				
Employment hi-tech services	4.38	4.76	5.13	5.18	5.22	4.85	152	1	++	0
relative to EU-15	147	149	151	143	147	139				

Inventive output and innovations in business

The output of the inventive process is traditionally measured by number of patents granted or applied for. A problem with this indicator is that there is no guarantee that patents – for which applications are costly - actually represent economic benefits.[9] Instead, they may have strategic value in excluding competitors from markets. Also, patenting varies by branches, since protecting new knowledge is more effective by application of the patent instrument in some branches, while e.g. secrecy is more effective in others.[10] Since path-dependence is an important explanatory factor for industrial structure, it is logical that the OECD (2005d) proposes that countries with ample patenting may be good at this because they developed strong intellectual property rights early on, which favoured industries in which this was a source of international competitiveness. Nonetheless, using patent data cautiously can yield interesting insights.

Sweden is one of the most patent-intensive countries in the world. This goes hand-in-hand with the fact that it is also very R&D-intensive. Table 11 illustrates this. It shows that Sweden has the highest ranking of EU-25 in number of European Patent Office (EPO) patents and in number of United States Patent and Trademark Office (USPTO) patents. Swedish patenting seems to have risen also in the 1990s as compared to many other countries. However, Table 11 also shows that Sweden is not the foremost nation in hi-tech patenting, but ranks second in USPTO and third in EPO hi-tech patents. This reflects that Sweden has important patenting capabilities in what is normally considered non-hi-tech industries. These non-hi-tech industries are for instance in automatic power generation (ABB), paper and paper products (e.g. SCA, StoraEnso) among other sectors.

[9] The full cost of the whole patenting procedure for a single patent lies in the realm of € 50,000.
[10] See e.g. Arundel (2001). See also Griliches (1990) for a discussion of the meaningfulness of patents as inventive indicators.

Table 11. Patenting in Sweden relative to the European Union; all patenting and hi-tech patenting (European Commission, 2005).

Item	1996	1997	1998	1999	2000	2001	2002	2003	Latest (EU-25 =100)	Rank among EU25	Current (1)	Trend (2)
EPO hi-tech patents	36.0	44.5	72.6	73.6	102.0	108.2	74.7	--	287	3	++	-
relative to EU-15	*308*	*293*	*373*	*317*	*348*	*321*	*242*	--				
USPTO hi-tech patents	17.1	16.4	24.6	30.2	37.8	37.3	38.1	--	404	2	++	0
relative to EU-15	*305*	*307*	*288*	*335*	*397*	*344*	*339*	--				
EPO patents	218.0	264.4	307.0	308.5	361.5	383.0	311.5	--	233	1	++	0
relative to EU-15	*224*	*230*	*236*	*219*	*228*	*228*	*197*	--				
USPTO patents	96.8	97.4	139.2	158.7	178.7	196.5	187.4	--	313	1	++	0
relative to EU-15	*215*	*207*	*228*	*252*	*268*	*274*	*263*	--				

Figure 6. Triadic patents per million of business R&D spending in OECD-countries, 2000 PPP-adjusted R&D spending, average per annum. Source: OECD (2005d).

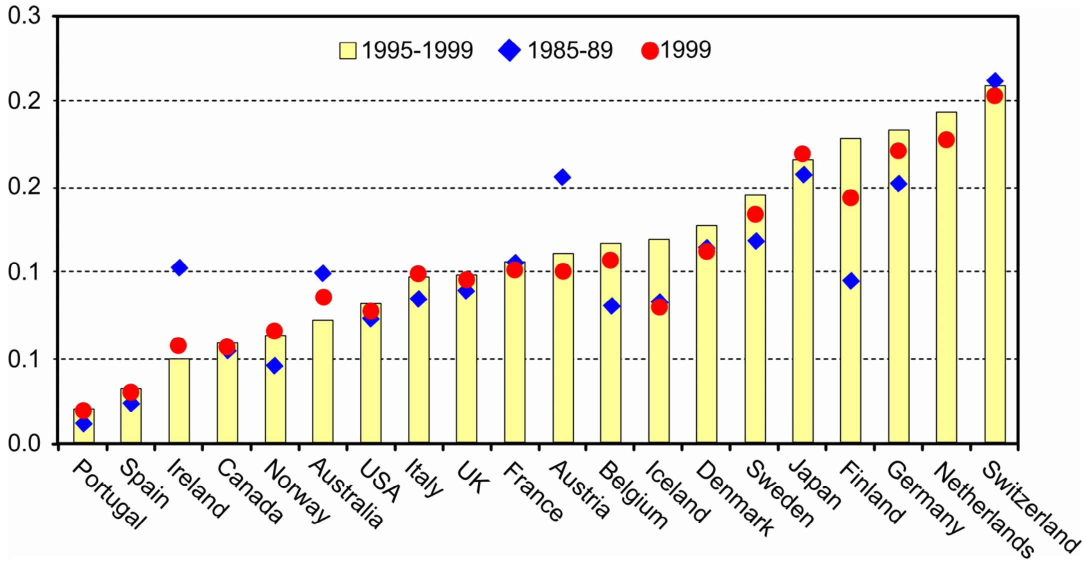
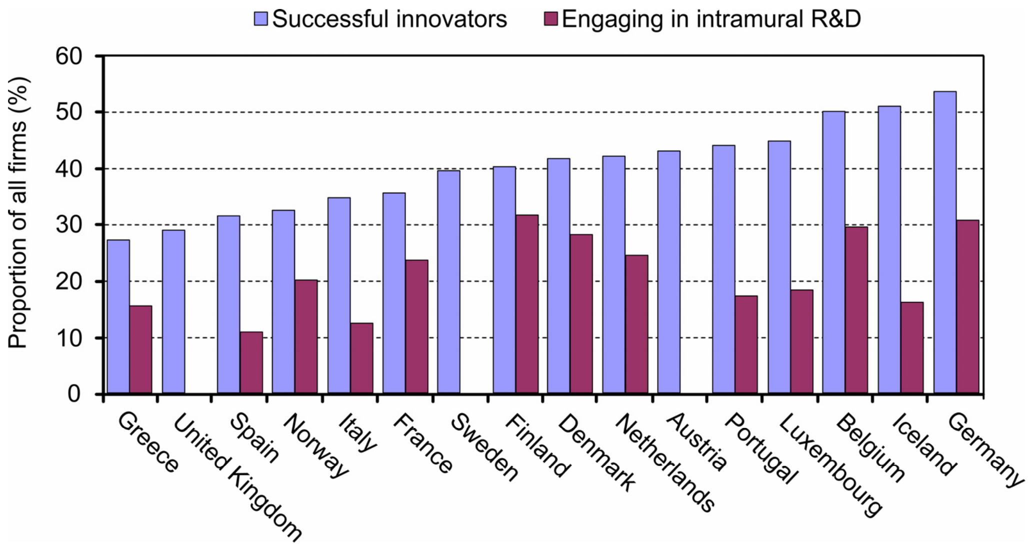


Figure 6 illustrates the extent to which patents are taken jointly in the three most important patent offices: the USPTO, EPO, and the Japanese Patent Office (JPO). This gives an indication of the importance firms attach to patenting worldwide. This number is then taken relative to the amount of R&D spending in the country. Sweden is by this measure not a world leader. This position is taken by Switzerland. By this measure Sweden ranks 'only' in position 7 of the listed countries.

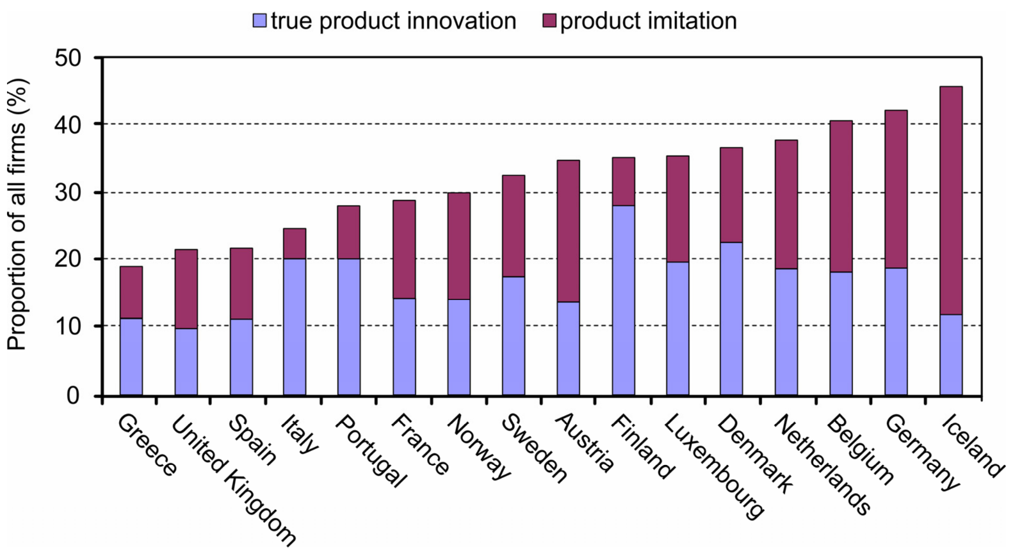
A different stance can be taken by examining *innovation indicators*, collected in the Community Innovation Surveys (CIS). These have been developed in response to lacking confidence in traditional indicators. Figure 7 illustrates the fact that innovativeness is not all about R&D in that among all firms, Sweden has fewer 'successful innovators' than many other countries in Europe. Another illustration is given by Figure 8. In the classical distinction between innovation and imitation, CIS-figures show that Swedish firms engage in innovative activities to a degree that is around the average for the EU. Around half of that consists of 'pure innovation' with the other half consisting of 'imitation'. This could be compared with for example Finland, which puts much greater stress on pure innovation.

Figure 7. Comparison of countries' innovative performance by various measures, 1998-2000.[1] Source: OECD (2005d).



1. Care should be taken when interpreting comparisons made between countries made with the aggregated data in CIS, as there are differences in the sample size used in the respective national components of the survey. For Austria, Sweden, and the United Kingdom, no data are available on the proportion of firms which engage in intramural R&D

Figure 8. Pure innovation and imitation in EU countries.[1] Source: OECD (2005d).



1. Care should be taken when interpreting comparisons made between countries with the aggregated data in CIS, as there are differences in the sample size used in the respective national components of the survey. Pure innovation refers to the proportion of firms which have introduced a product new to the market. Imitation refers to the proportion of firms which have introduced a product new to the enterprise but not new to the market.
Data on the distinction between pure innovation and imitation are available only for product innovation, and not for process innovation.

Table 12 shows the importance of innovation among SMEs. The table further strengthens the impression that SMEs encounter serious difficulties in Sweden. Swedish in-house innovation among SMEs only ranks 8th among the EU-25 group. Swedish innovation cooperation, though, seems to be rather extensive among SMEs. Also, SMEs seem to be heavy on technological innovation, since on non-technological innovation Sweden ranks only as the 12th nation. This further corroborates the impression that the Swedish innovation system leans heavily on technological innovation, as indicated by the wealth of R&D and patenting taking place.

Table 12. Enterprises' innovation activity in Sweden. Source: European Commission (2005).

Item	EU-25 = 100	Rank among EU-25	Current (1)
SMEs innovation in-house	111	8	0
SMEs innovation cooperation	189	3	++
SMEs non-tech innovation	90	12	0

Access to venture capital is often crucial at early stages of business formation. Table 13 provides some benchmarking values of relevance to this aspect. Sweden performs relatively badly on hi-tech venture capital, especially when considering that value-added in hi-tech manufacturing is above the EU-25 average. Sweden performs extremely well on early stage venture capital. At the same time, it seems that the flow of such capital has only started to be effective since 2000. The European Trend Chart on Innovation (2005) offers a more balanced view by stating that "it can even be the case that the whole level of seed capital in the total European market is too low".

It should be emphasized that international comparisons are shaky in this area, and that interpreting aggregate data is difficult. There are plenty of micro-level observations suggesting that venture capital markets in Sweden are weak at supporting high-risk, high-tech and potentially high-growth ventures in early stages (Lindholm Dahlstrand, 1997a and 1997b; NUTEK, 2005). The problems are likely to be found in a combination of financial market conditions and conditions for entrepreneurship and risk-taking for individuals, versus the opportunities they are faced with by opting for more secure opportunities in big business or the public sector

Table 13. Innovation finance, output and markets in Sweden. Source: European Commission (2005).

Item	1996	1997	1998	1999	2000	2001	2002	2003	EU-25 = 100	Rank EU-25	Current (1)	Trend
Hi-tech venture capital	--	--	--	--	46	48	53	48	95	8	0	(3)
relative to EU-15	--	--	--	--	*95*	*94*	*102*	*95*				
Early stage venture capital	0.003	0.003	0.007	0.057	0.095	0.093	0.097	0.081	322	1	++	(3)
relative to EU-15	*55*	*31*	*43*	*195*	*168*	*154*	*262*	*322*				
Value-added hi-tech manufacturing	16.8	17.0	17.5	18.9	16.0	15.9	--	--	125	7	+	-
relative to EU-15	*143*	*139*	*140*	*144*	*117*	*112*	--	--				

Inventive output and innovations in non-business sectors

Not only does Sweden have a lot of business R&D but there are also high volumes of university R&D, as was seen from Figure 4. This is clearly an important area for public policy. Sweden's institute sector, by contrast, is miniscule by international standards; it only represents about 3 per cent of public research funds. Instead, the HE system takes on tasks which are normally to a higher extent the job of the institute sector in other countries, such as "the third task" and more applied types of research. Thus, the HE sector carries out tasks that are more or less politically driven. A recent report by Sörlin (2004) calls into question this division of labour and argues for a higher importance to be attached to the institute sector.

Since there is such a large emphasis on the HE sector, its contributions to society should be scrutinized. It cannot easily be investigated in terms of patenting, because in Sweden the property rights to inventions are attributed to the researcher ("lärarundantaget"). Nevertheless, these property rights may be shared with a kind of technology transfer office (such as Chalmers Technology Licensing in Gothenburg, or Karolinska Innovations AB in Stockholm, see Andersson et al., 2002) *if* the researcher agrees. In addition, academic staff has considerable freedom to engage in societal activities, which are rather broadly defined (the so-called third task). This means that they are normally allowed a certain percentage (often 20 per cent) above their normal working time to engage in consultancy, starting up firms, patenting in separate firms, writing debate articles etc., i.e. activities that depend on the nature of their field. Many people in academia take advantage of this opportunity. Universities often have a lax view of this since it is considered beneficial that staff can earn extra money, because wage levels are normally considered to be uncompetitive with those of the private sector. However, there are reasons to believe that these side-activities may not contribute significantly to "growth", simply because they are by definition side-activities and should remain so.

As in other countries, most companies in Sweden are small. Most firms started by academic staff do not grow at all, do not generate much profit, and are not started in branches in which the founders have any particular knowledge advantages. Evidence about last-year engineering students' future business career plans reveal that they think that starting a business ranks as less likely, in decreasing order, than being employed, continued studies, and unemployment. Wiklund (2005) concludes that the incentives to start businesses are too poor, which is related to the obtaining of benefits under the welfare-system being dependent on the individual's employment-status. He argues that policy should aim at "balancing" the incentives confronting individuals in the cross-roads between the career paths of the employed vs. those of the entrepreneur.

In the academic world, where regular scientific activity is the norm for advancing, scientific contributions ("publish or perish") are the most important qualifier for advancement in academia. External examiners and reviewers ensure that nepotism is kept out of the system. However, there does not seem to be much pressure on tenured staff to publish. At the same time, mobility in academia is very low. A measure of this is the proportion of active PhDs in 2004 that work at the same university where they took their doctoral degree. This rate was 78 per cent according to Statistics Sweden (2005b).[11] The number of hours taught matters for positions that have teaching associated with them. But the actual quality of teaching is less clearly defined within the Swedish system. Most universities and university colleges seem to have teacher awards, but individual teacher evaluations are rarely (if ever) undertaken.

[11] Not all universities are included in this figure. The figure comprises the universities in Uppsala, Lund, Gothenburg, Stockholm, Umeå, Linköping, Karolinska institutet, the Royal Institute of Technology, Chalmers University of Technology, and the Swedish University of Agricultural Sciences.

This means that there are limited data on the productivity of researchers at universities. Data on patenting by university researchers outside their official job are almost by definition hard to obtain, although researchers are trying to obtain figures by matching registers. The evidence discussed here is therefore limited to the number and the quality of publications. The evidence in Figure 9 [12] shows that the Swedish university system, in terms of number of published papers per capita, is able to keep up with international competition. Andersson (2005) reports that Sweden excels foremost in publications/capita in medicine (rank 1), and ranks second in engineering and natural sciences publications.

Figure 9. Scientific publications, internationally acknowledged journals, 2000-2001. Source: National Science Indicators (NSI) database (2002).

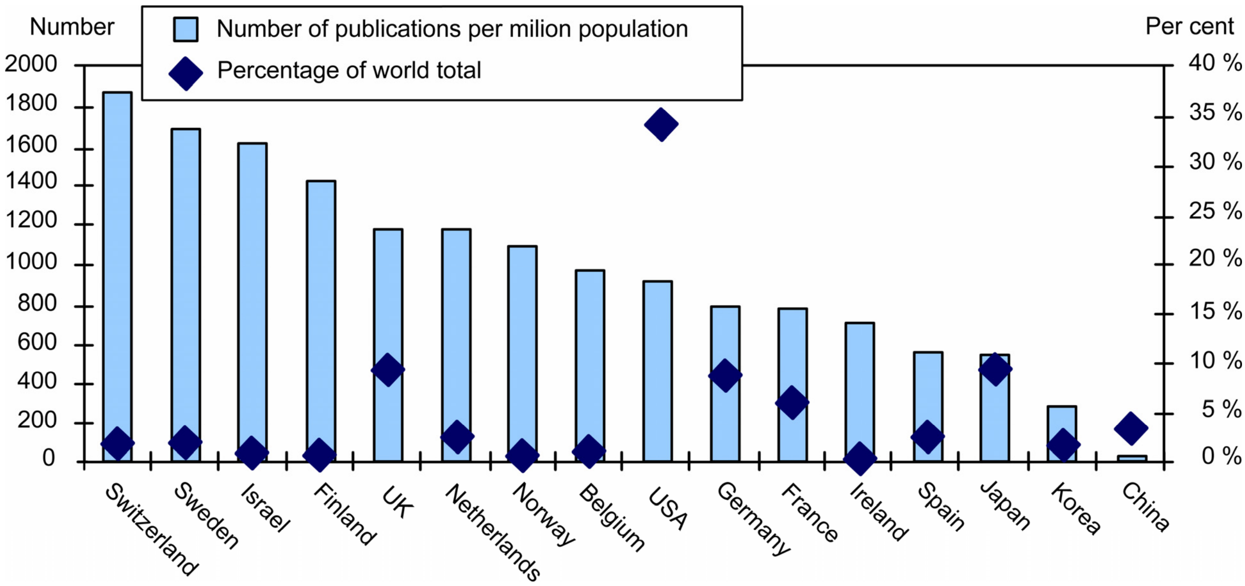


Figure 9 does not show the quality of this scientific output, only that it has passed a peer-review process. The impact of the output is commonly measured, albeit imperfectly, by citation indicators. Sweden's leading position in medicine may be at risk, however. In a comparison between Western European countries[13], the Swedish Research Council (2003) shows not only that Sweden's share of internationally published articles in medicine has been falling for a long period (Figure 10), but also that Swedish publications have become less cited in later years (Figure 11). On the other hand, Sweden seems to fare better over time in some areas; in particular in technical sciences (both in terms of number of publications and citations).

[12] This material does not discriminate between university-/non-university scientific contribution. In what follows it is assumed that most of these publications originate from university-employed, which seems like a reasonable first-hand approximation.

[13] The compared countries are Austria, Belgium, Denmark, Finland, France, Germany, The Netherlands, Norway, Sweden, Switzerland, and the UK.

Figure 10. The Swedish share in per cent of Western European countries' articles published. Source: Swedish Research Council (2003).

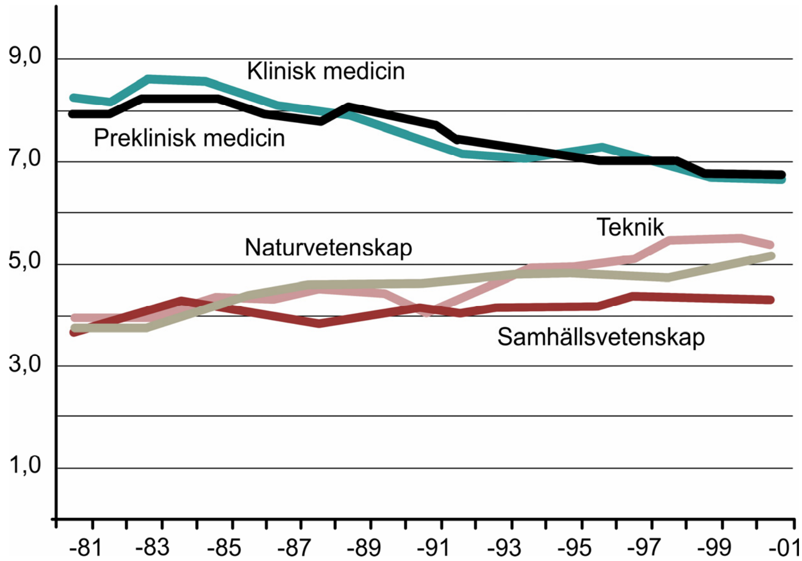
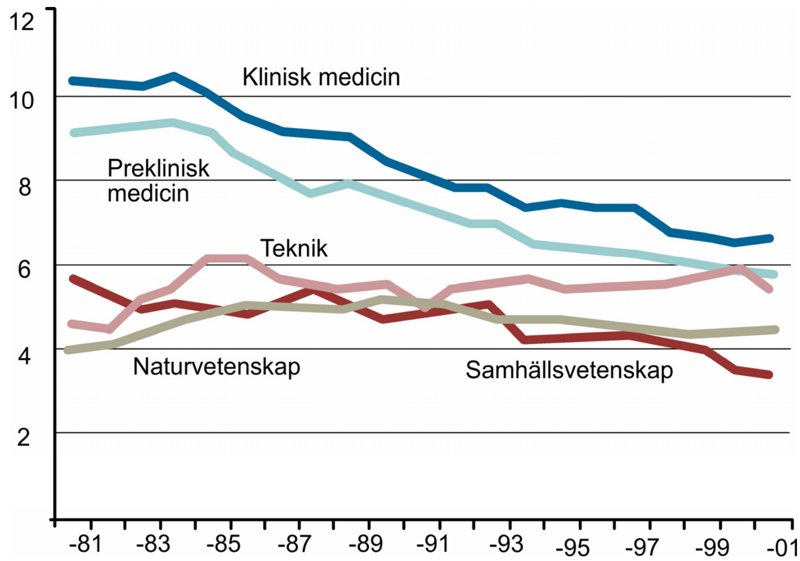


Figure 11. The Swedish share of Western European citations, in per cent. Source: Swedish Research Council (2003).



The labour market for knowledge

From an international perspective, the Swedish labour market is characterized by high employment rates, a relatively low unemployment rate (Table 14), and high taxes on income, which to a high extent are used for income redistribution purposes. The Gini-coefficient clearly shows this. Sweden, together with Denmark, has the most egalitarian income distribution of all OECD countries (OECD, 2005a). Statistics Sweden (2003a), however, shows that the Gini-coefficient has increased rather rapidly in the period 1991-2001.

In 1991-93, the Swedish economy was hit hard by a combination of factors: the international recession, unfavourable cost conditions for Swedish businesses, a policy shift towards a low inflation-target, etc. At the same time many policy changes were set to be implemented. Many of these measures probably required some time for employment reallocation to occur smoothly, in which case favourable growth conditions would have been beneficial. For example, there was a shift to fewer subsidies for housing, which led to a lower demand in the construction industry. As a result, many construction workers became unemployed. From an unemployment rate of less than two per cent in 1990, the rate was 9.1 per cent in 1993 (Table 14).

Table 14. Unemployment rates in active share of population 1993–2002, per cent. Source: Eurostat (2003).

1993		1996		1999		2002	
Japan	2.5	Japan	3.4	Netherlands	3.2	Netherlands	2.7
Austria	4.0	Austria	4.4	Norway	3.2	Norway	3.9
Portugal	5.6	Norway	4.8	Austria	3.9	Austria	4.3
Norway	6.0	USA	5.4	USA	4.2	Ireland	4.4
Netherlands	6.2	Netherlands	6.0	Portugal	4.5	Denmark	4.5
USA	6.8	Denmark	6.3	Japan	4.7	**Sweden**	**4.9**
Germany	7.7	Portugal	7.3	Denmark	4.8	Portugal	5.1
Belgium	8.6	UK	8.0	Ireland	5.6	UK	5.1
Sweden	**9.1**	Germany	8.7	UK	5.9	Japan	5.4
Denmark	9.6	Belgium	9.5	**Sweden**	**6.7**	USA	5.8
UK	10.0	**Sweden**	**9.6**	Germany	8.4	Belgium	7.3
Italy	10.1	Italy	11.5	Belgium	8.6	Germany	8.6
France	11.3	Ireland	11.7	Finland	10.2	France	8.7
Ireland	15.6	France	11.9	France	10.7	Italy	9.0
Finland	16.3	Finland	14.6	Italy	11.3	Finland	9.1
Spain	18.6	Spain	18.1	Spain	12.8	Spain	11.3

This created enormous strains on the public sector, too many to discuss at length here. Suffice it to say that this had important repercussions for the HE sector.

Provision of human capital from higher education

In an attempt to turn around the bad economic situation of the early 90s, the Swedish government invested massively in HE. Swedish universities are presently not allowed to charge fees to attending students but are dependent on government funds to be able to accommodate them.

Table 15 shows the expansion in the number of students of the HE sector 1995-2003, and the development of R&D man-years. This table clearly shows that HE is increasingly becoming mass education. The yearly cohort of new-born amounts to roughly 100,000 individuals in Sweden. It becomes apparent that a rather high percentage of the young population now goes through some sort of HE.

Table 15. Number of students in HE, man-years in R&D in the HE sector, and number of students in relation to number of R&D man-years, biennial data 1995-2003. Source: Statistics Sweden (2005a) and own calculations.

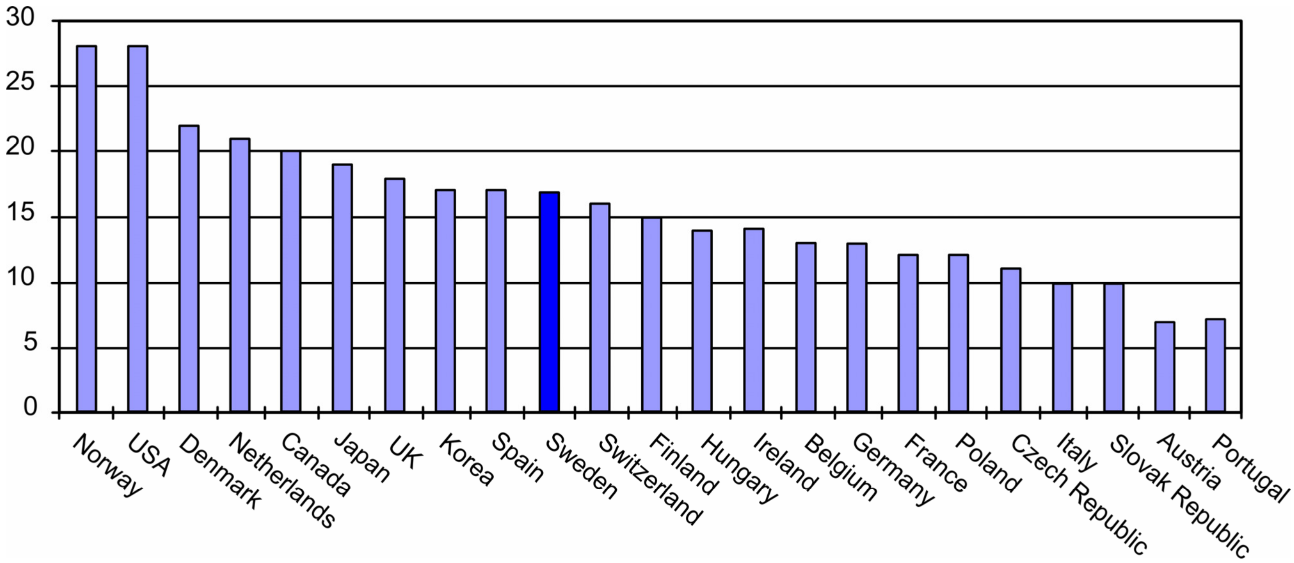
Item	1995	1997	1999	2001	2003
A. Students*	258 166	282 139	310 945	330 234	370 193
B. R&D man-years**	17 300	18 200	19 200	19 800	21 500
C = A/B	14.9	15.5	16.2	16.7	17.2

* This category comprises Swedish citizen students active domestically. It excludes a category "technical base-year" comprising roughly 3 000 students yearly, for which time-series could not be compiled consistently. Furthermore, foreign exchange students active in Sweden are not included.

**R&D man-years are in the HE sector and institutes closely associated with them.

Figure 12 shows that Swedish tertiary education attainment now is around average of OECD countries. Swedish tertiary education was significantly below the average before the large expansion of the 1990s.

Figure 12. Percentage of active population, 25-64 years old, with tertiary education, 2002. Source: OECD (2003).



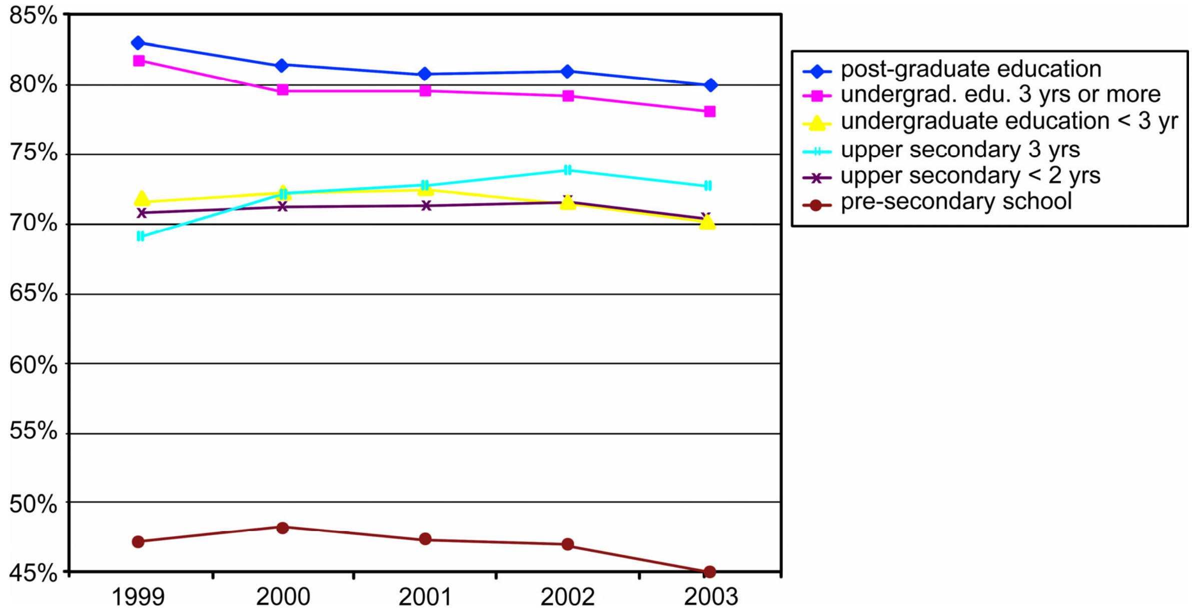
As reported above, the economic crisis of the early 1990s crisis saw the advent of "European" levels of unemployment in Sweden. In response, people increasingly tried to improve their competitiveness in the labour market by attaining higher education. The kind of jobs that the labour market started to deliver after the crisis were more frequently tilted towards temporary or short-term positions, thus spurring a higher demand for education in order to upgrade competencies and to avoid unemployment. Education therefore acts much more as a sorting mechanism than before.

Does it then pay to undergo education? In terms of chances of being employed, aggregate figures seem to indicate that this is the case.[14] Figure 13 shows employment levels in per cent for different levels of education. Roughly, one may distinguish three separate groups. First, there is a smaller group with less than 9 years of education. Among these, less than 50 per cent are employed. The second group

[14] This neglects the possibility of *selection bias,* see below.

comprises people with upper secondary and undergraduate university education.[15] Among these, employment varies between 68 and 74 per cent over the period. However, education does not pay off uniformly in terms of employment: those with shorter undergraduate education are to a somewhat lesser extent employed than people without this education in the latter half of the period. The real winners in terms of employment are those with really long education (more than three years of undergraduate education or post-graduate education). However, there is a slight downward tendency among this group.

Figure 13. Employment in per cent of the Swedish work force with different levels of education.



If education appears to pay off in terms of employment, what about earnings? The OECD's *Education at a glance* (OECD, 2003) compares wage differences between males and females of different education levels across OECD countries. In all, it pays to go from below upper secondary to post-secondary, non-tertiary education and from post-secondary non-tertiary to tertiary education. However, the private rates of return are not impressive; out of 9 countries[16] the rates of return are 8.8 per cent for men and 7.3 per cent for women of obtaining a HE degree in Sweden as compared to upper secondary education. The returns are only lower in Australia (M: 6.6 %, F: 6.5%) and Denmark (M: 6.7 %, F: 6.1 %). In all countries, there are substantial earning differentials between males and females, the latter earning around 70 per cent of male earnings and Sweden is not unusual in this respect. Further, there are no particular trends in earning differentials between the sexes, nor are there trends in earnings depending on education levels. Sweden does stand out in certain respects:

- There are negative returns to education in one case: It does not pay to obtain upper secondary or post-secondary education, non-tertiary education coming from a background of lower secondary education and being 40 years old. Sweden shares this feature with Finland and Australia. In all three the tax-system is responsible for creating disincentives.

[15] Upper secondary schooling usually begins at 15 or 16. Education is taught more along subject lines (OECD, 2003). Undergraduate students refer to higher education students striving for their first HE degree. Tertiary education is synonymous with higher (i.e. university) education (Longman, 2003).

[16] The other countries for which rates are shown are Australia, Denmark, Finland, Hungary, Spain, Switzerland, the UK, and the US.

- Social internal rates of return are for most countries lower than private returns on the upper secondary education level. However, in Sweden social returns are much higher than the private returns.

The above is indicative of anomalies, especially associated with upper secondary education. The level of salaries also compare weakly with returns in the social safety system. In recent years, Sweden obtained the highest numbers of working-age individuals on sick leave or in early retirement of all countries, despite reports of a relatively healthy work environment. There has also been a chronic net migration abroad of highly skilled workers, while many skilled immigrants have been poorly integrated in the labour market (Andersson and Friberg, 2005).

Gustavsson (2005) examines changes in the returns to education in Sweden in the period 1992-2001. The base data material consists of roughly 62,000 to 108,000 observations of individual register data, depending on year. The paper suggests that the university wage premium[17] has increased in the 1990s. Moreover, the premium has increased more for men than females and more for people employed in the private rather than the public sector. This means that a long period of decline in the university wage premium that followed from the late 1960s until the early 1980s has been followed by an increase, although the entire decline in the premium from the 1970s has not yet been eradicated. However, most of the increase in the premium is accounted for by the private sector. The premium for doctoral education[18] has increased equally among men and women, but the premium increased *more* in the public sector. An interesting result is that the premium for university education increases, despite a much higher relative supply of highly educated people. This stands in stark contrast to earlier decades when lower returns to HE at the same time were associated with higher relative supply of highly educated. This means that the growth in relative demand for highly educated workers outpaces the higher relative supply of highly educated, since the wage premium has increased. In upper secondary education, the premium[19] shows no increasing trend. After having decreased from 1968 until the early 1980s, the premium remains the same from then on.

The above perspective to some extent masks that many problems co-exist within the HE system. Various studies have shown that the pecuniary return for investment in human capital is lower in Sweden than in other countries, especially due to the highly progressive taxation combined with flat remuneration curves (IMD, 2005; Ljunglöf, 2004). Ljunglöf's (2004) perspective is to examine life-time incomes for 27 different academic educations.[20] The overall return to academic education is 6 per cent, but for 19 of 27 groups, the returns are less than 5 per cent, and for 9 groups returns are negative. Negative returns are predominantly found for education intended for occupations in the public sector, such as: occupational therapists, librarians, and physiotherapists. Females are overrepresented in these groups. Despite this, women overall have higher returns on education than men in this investigation.

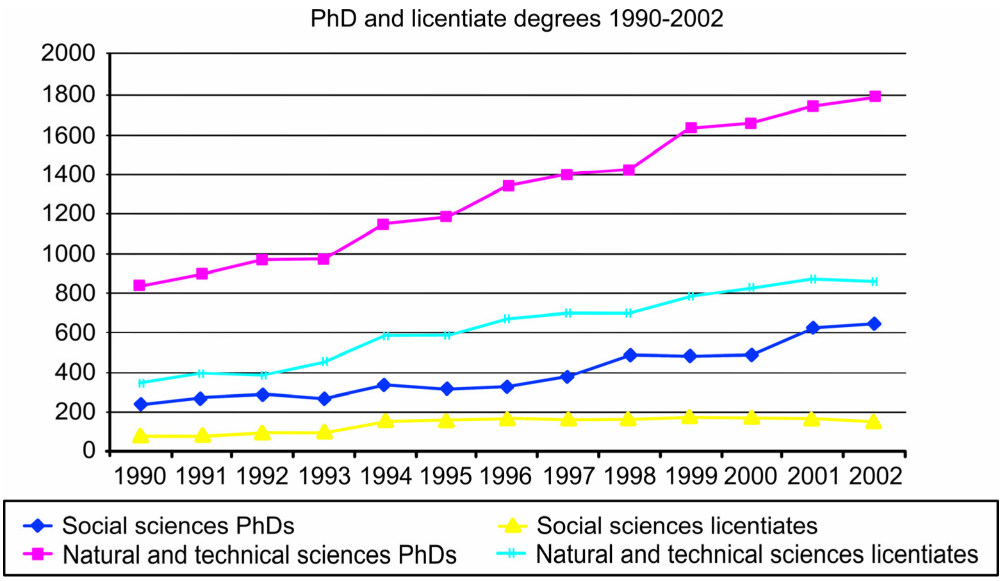
These studies yield somewhat different results, that are dependent on the methods and assumptions used. A problem of the study by Gustavsson (2005) is that he does not control for taxes or social benefits. Although the returns on university education may have increased in later years, they are still low by international standards. Many academic paths are not profitable in monetary terms, and may even offer a negative payback. Further, problems arise in making upper secondary education by itself profitable for the individual. After 9 years of schooling the prospective "tired-of-school" student may find little motivation in that after an additional 3 years, he/she will have lost in life-time income, and must go through an additional number of years of university education. Changing all upper secondary education into three-year programmes a few years back may therefore have been less socio-

[17] The university premium is defined as the wage differential between university and 3-year upper secondary school.
[18] This premium is defined as the wage differential between doctoral education and university education.
[19] This premium defined as the wage differential between 3-year upper secondary school and primary school.
[20] Cross-sectional data over age-groups with the same education are used to proxy for life time income.

economically motivated. The conclusion to be drawn from this discussion is that the decision to undergo education may more be driven by the increased probability of obtaining work than the potential of obtaining higher economic returns on education. This means that if labour markets become tighter, people will most likely not go through burdensome education with unsure returns.

In doctoral education in Sweden, there is a longer term degree corresponding to four years of full-time studies. A shorter term degree is the licentiate degree, which requires two years of full-time studies. However, most doctoral students also teach so it normally takes them longer to finish their studies. Figure 14 shows the number of PhD and licentiate degrees awarded 1990-2002 in social sciences and natural and technical sciences.[21] These show clearly rising trends in the number of PhD degrees awarded. In fact, the number of natural science PhDs has more than doubled during the period. The number of PhDs in social sciences has risen even faster, but starting from a lower level. Licentiate degrees have also risen. In natural sciences there is also a clear upward trend and a doubling. In social sciences, though, the rise is less pronounced; the number seems to be stable from 1995 onwards.

Figure 14. PhDs and licentiate degrees awarded in Sweden 1990-2002; social sciences and natural and technical sciences. Sources: Statistics Sweden (2005a) and own calculations.



Unemployment among PhDs and licentiates is quite low. A report from Statistics Sweden (2003b) shows that among degree holders in 2003 that graduated 1994/95 and 1995/96, average unemployment was 2 per cent, with rather little variation between fields. Unemployment was relatively high in humanities and religious sciences (about 5 per cent). Among those graduating in 1999/00 and 2000/01, the unemployment rate was 3 per cent in 2003. There were more marked differences among these categories of unemployed degree holder. Humanities and religious science unemployment rates were 9 per cent, and in natural sciences 6 per cent. These are aggregate numbers though. The Swedish Association of University Teachers (SULF) reports in SULF (2005) that unemployment among 25-29 year olds with a postgraduate degree is 8.6 per cent, while it is only 5.3 per cent among those with an undergraduate degree. Thus, the rapid expansion in the number of postgraduates seems to have given rise to higher unemployment rates among young people.

Table 16 shows sector of employment in per cent among PhD degree and licentiate degree holders in the categories university/university college not university/university college, and no response split by

[21] Social sciences here refer to the fields: Humanities and religious sciences, legal sciences, and social sciences. Natural and technical sciences refer to the fields: Pharmacy, mathematics, medical sciences, natural sciences, odontology, forest and agricultural sciences, engineering and technology, and veterinary medicine.

the categories social sciences and natural and technical sciences. The table shows the expected result that natural and technical sciences PhD and licentiate degree holders have better employment opportunities outside academia compared with graduates from the social sciences. Elg (2005) reports that of a total of 36,097 PhDs and licentiates, increasing numbers are working in the private sector; up from 35 to 45 per cent of all degree holders from 1990 to 2000. The share of degree holders is somewhat less than one per cent of all employed.

Table 16. Sector of employment in Sweden for PhD and licentiate degree holders: social sciences and natural and technical sciences. Source: Statistics Sweden (2005a) and own calculations.

Sector of employment	Social sciences	Natural and technical sciences
University/university college	65%	41%
Not in university/university college	34%	59%
No response	1%	0%

Are there obstacles associated with making a career in academia? The following diagrams (Figure 15 – Figure 17) show the age distribution of employed within three major categories of employment in HE: doctoral students, postdocs ("forskarassistenter")[22], and professors. Data is shown split by male/female and by social sciences and natural and technical sciences, respectively. This is somewhat indicative of the speed of career paths within HE, taken from a cross-section.

Social science and N&T science distributions are highly correlated, although people seem to be somewhat younger in N&T. The most common age group among doctoral students is 25-29 years in N&T, whereas it is the 30-34 year group in social sciences. The 25-29 year group represents more than 50 per cent of all active doctoral students in N&T. It is much more common among social sciences to be a doctoral student in the higher age groups. Somewhat similar patterns emerge among postdocs. Here the most common group to be employed is the 35-39 year category for both social sciences and N&T. Again, the higher age groups are more common in social sciences. The average professor, as shown by this cross-section, is in the 55-59 year group for all categories except females in social sciences. This means that the average professor has a relatively short career, less than 10 years before retirement at 65.

From the diagrams, we find that females in all working group categories are older, except for the professor category in N&T sciences, where women on average are somewhat younger than men. A quick look at the aggregate absolute values (Table 17) reveal that while the numbers of doctoral students are approximately equal across gender groups in social sciences, females are somewhat fewer than men in N&T sciences. At the postdoc level, there are many fewer females than males in N&T, whereas the numbers are almost the same in social sciences. Among professors there are very few females, especially in N&T. These figures also reveal that the labour market in academia is much tighter for N&T PhDs, since in relative terms many fewer are able to go on to the postdoc level compared with social sciences.

To sum up these results: Career paths in academia are slow. Most full professors active today have less than ten years left to retirement. This holds for N&T sciences and social sciences alike. The time from doctoral student to postdoc is not overly long, but there is a marked difference between postdoc and full professor. Here it seems to take decades to reach the highest position. There is an important intermediate position, the associate professor, for which we could not find data, but the career path nonetheless seems to be slow. Career paths in N&T seem to be somewhat faster than in social sciences,

[22] The category postdocs is not only composed of the Swedish category forskarassistenter,. We have chosen to report only this group because the position of forskarassistent mainly consists of researchers as opposed to other work categories.

possibly because of more options to move to the private sector. Further examination of data corroborates the pattern of inertia in the academic system. Social sciences appear be more egalitarian among the sexes. Women are much more common in social sciences in all groups. In N&T the selection process in natural sciences does not favour women. While it is generally the case that doctoral students should to a higher extent leave academia after their PhD, women seem to lose out in the competition for the attractive posts higher up in the hierarchy to a higher extent than in social sciences.

Figure 15. Distribution of doctoral students in Sweden across age groups in 2004. Source: Statistics Sweden (2005a) and own calculations.

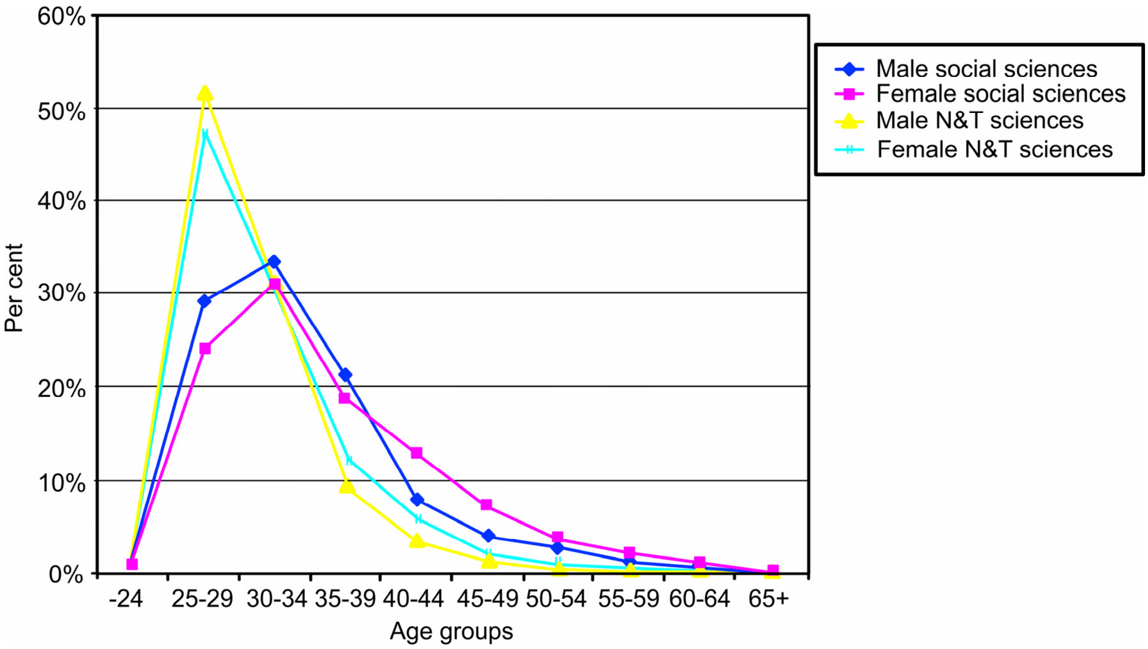


Figure 16. Distribution of postdocs ("forskarassistenter") in Sweden across age groups in 2004. Source: Statistics Sweden (2005a) and own calculations.

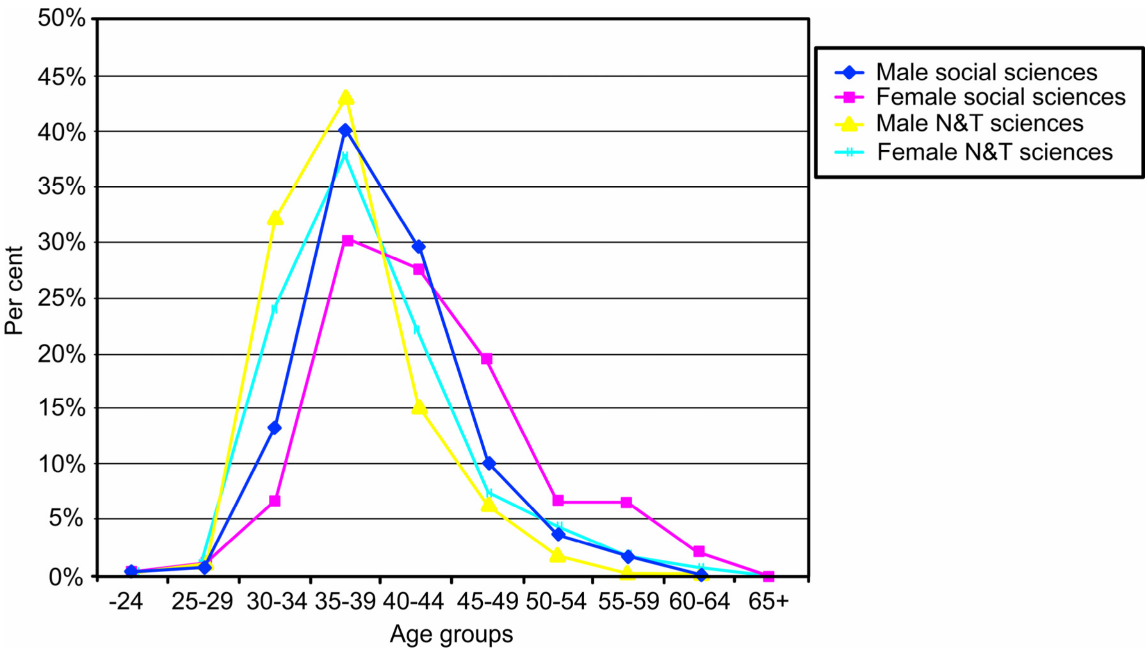


Figure 17. Distribution of professors in Sweden across age groups in 2004. Source: Statistics Sweden (2005a) and own calculations.

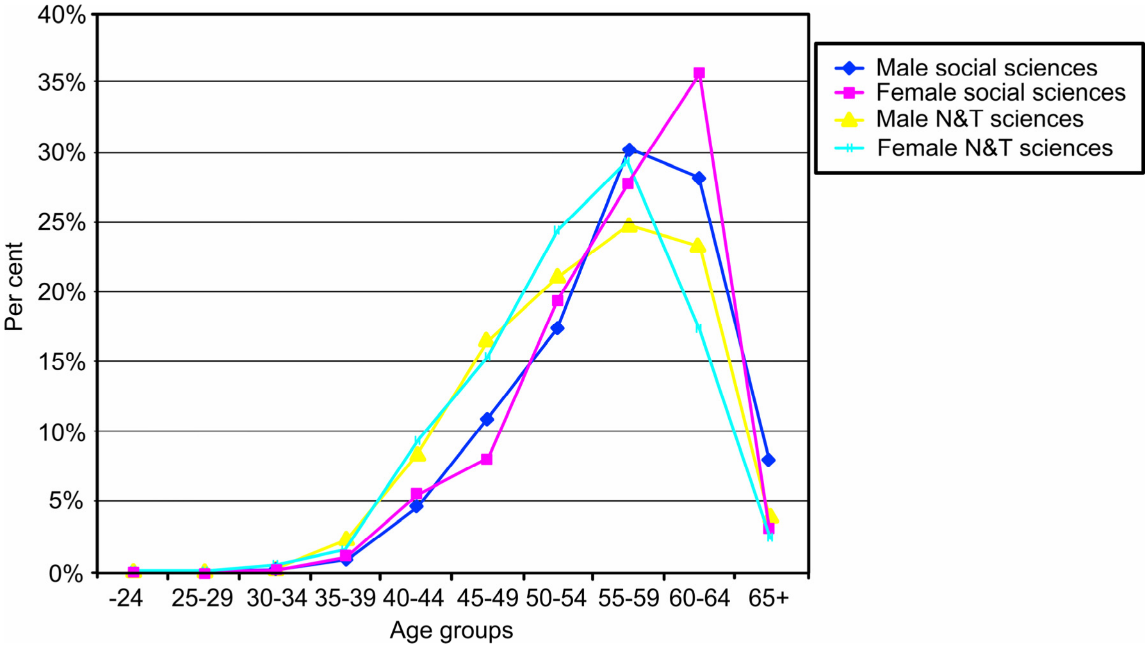


Table 17. Absolute numbers, male and females among doctoral students, postdocs, and professors in Sweden, 2004. Source: Statistics Sweden (2005a) and own calculations.

Item	Doctoral students	Postdocs	Professors
Male social sciences	933	110	870
Female social sciences	1 289	104	255
Male N&T sciences	3 846	487	2 291
Female N&T sciences	2 682	265	321

Taxes on labour income

Swedish taxes on labour income remain among the world's highest. Due to high ambitions of the Swedish welfare system, benefits - and therefore average and marginal tax rates - are intrinsically linked to the number of children. The OECD (2005c) divides these statistics by household type. SINGLE1 represents a single person with no child earning 67 % of the average person wage (APW); SINGLE2 represents a single with no child earning 100% of APW; SINGLE3 represents a single with no child earning 167 % of APW; SINGLE4 represents a single with 2 children earning 67 % of APW. In the "married" classifications we have always a married couple with 2 children, where for MARRIED1 the principal earner has 100 % of APW and the spouse 0 % of APW. For MARRIED2 the principal earner has 100 % of APW and the spouse 33 % of APW. For MARRIED3 the principal earner has 100 % of APW and the spouse 67 % of APW. In MARRIED4 the principal earner gets 100 % of APW with the spouse earning 33 % of APW. The average tax rates for these groups in 1998 and 2004 are shown in Table 18. Social security fees are included here.

The high income taxes cause a number of disincentives to knowledge-intensive economic activity, including education, entrepreneurship and risk-taking more broadly. The impact is particularly worsened by the combination of high income- and other taxes, such as the high level of indirect taxation, the (internationally practically unique) wealth tax, the housing tax, taxes on dividends, etc. The recent removal of the inheritance- and gift[23]-taxes provided some, but only limited, relief. Monetary returns represent far from the only driving force for human beings aspiring to learn and achieve. However, the bias against an entrepreneurial climate is further reinforced by social attitudes, especially in certain rural areas. Such sentiments are perpetuated by the tax structure.

Table 18. Employees' social security costs + Income tax (Average rate in per cent) in Sweden in 1998 and 2004. Source: OECD (2005c).

	TYPE	SINGLE 1	SINGLE 2	SINGLE 3	SINGLE 4	MARRIED 1	MARRIED 2	MARRIED 3	MARRIED 4
Year									
1998		32.5529	34.4133	42.0427	32.5529	34.4133	33.7163	33.6691	33.7163
2004		28.6316	31.0185	36.8426	28.6316	31.0185	29.4610	30.1115	29.4610

Table 19. Total tax wedge (Marginal rate in per cent) in Sweden in 1998 and 2004. Source: OECD (2005c).

	TYPE	SINGLE 1	SINGLE 2	SINGLE 3	SINGLE 4	MARRIED 1	MARRIED 2	MARRIED 3	MARRIED 4
Year									
1998		53.8789	51.5669	66.7421	53.8789	51.5669	51.5669	51.5669	51.5669
2004		51.6651	51.6651	63.4589	51.6651	51.6651	51.6651	51.6651	51.6651

Table 19 shows the marginal tax rate for the corresponding categories. Table 18 reveals that average tax rates (when including income and social security costs) have been lowered in recent years. It is unclear whether this trend will continue. In Swedish politics, this remains clearly a political dividing line between left and right. The main cause for the lower taxes resides in lower so-called "egenavgifter" (social security contributions, or payroll tax for self-employed), temporary taxes that were introduced in the mid 1990s to alleviate the state's budgetary problems. Accordingly, the average tax rate has been lowered by some 3-6 percentage points depending on category. The marginal tax rates remain high in international comparison. The backbone of the tax system has barely changed since the major tax reform of 1991, where a substantial part of the progressivity of the Swedish tax system was removed. The marginal tax rate was essentially the same from 1998-2004, with some minor reductions for the singles categories. One singles group stands out, it is SINGLE3. This is the high-income single person with no children, who apparently does not benefit from working more hours in the Swedish system of generous child support.

ICT: Infrastructure and Policies

European Commission (2005, replicated in Table 20) shows that Swedish ICT expenditures ranked 6th is stable above the EU-15 average.

[23] On transfer of taxable wealth or capital by parents to their children or between spouses

Table 20. Internet and ICT infrastructure in Sweden. Source: European Commission (2005).

Item	1998	1999	2000	2001	2002	2003	Latest (EU-25 =100)	Rank among EU-25	Current (1)	Trend (2)
Internet (comp. indicator)	--	--	--	--	1.00		--	1		
ICT expenditures	--	--	8.5	8.6	8.4	8.2	131	6	+	0
relative to EU-15	--	--	131	134	138	132				

Sweden ranks as one of the foremost nations in the Internet and ICT infrastructure (Table 20 and International Data Corporation, in Swedish government (2004)). The principal reasons for this ranking are skills and good infrastructure. Swedish universities were connected online earlier than most other European universities (Swedish government (2004)).

Internet and computers

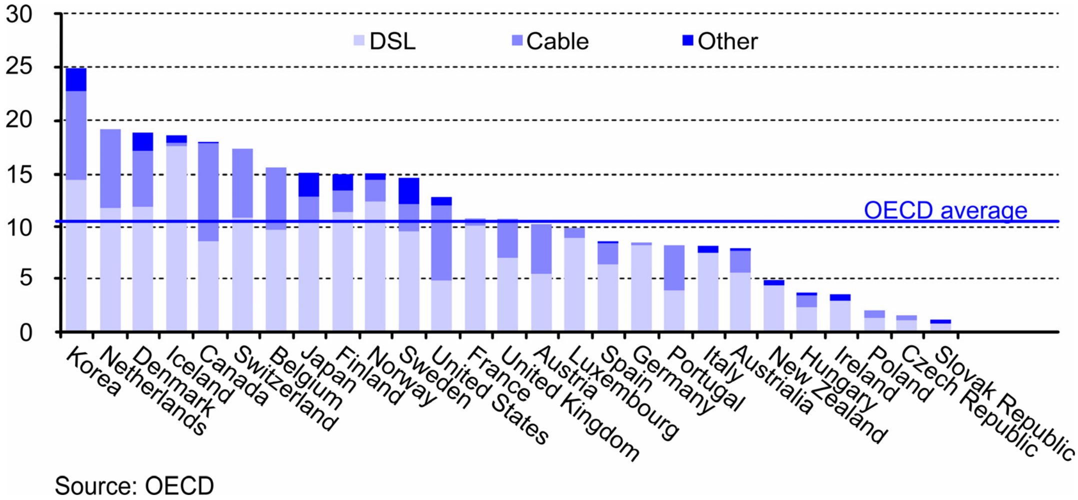
The tools in Swedish IT-policies which seem to have been most influential are broadband access, "the PC reform", and the National Action Programme for ICT in Schools (ItiS). The PC reform was launched at the beginning of 1998. Businesses are offered tax relief for computers that employees can use at home. The offer must be given to all employees. Employees then have the opportunity to rent computers much cheaper than would be the case on the regular market (ibid). Most of these rental activities are connected with training programmes ("PC driver's licenses") that the renter is usually required to pass. This program has probably been effective in raising the IT competence of the working population. According to a study by Statistics Sweden (2002), 71 per cent of the population 16-74 years old had a desktop computer in the home, and 19 per cent a laptop.

The second major policy has been to procure broadband access. Expansion of broadband has occurred through a variety of policies including grant funding to municipalities and individual subscribers and expansion of the national backbone network to all municipal areas (Swedish government (2004)). Roughly € 550 million[24] was set aside for broadband expansion by the Swedish parliament (ibid). But the Swedish government (2004) expresses concerns: "Expansion has taken longer than expected." The paper seems to think that bad market conditions during the early years of the millennium were responsible. However, despite major policy efforts, Sweden lags behind several other countries in terms of broadband access according to recent statistics from the OECD (2004b), illustrated in Figure 18.

The third big policy programme (ITiS) provided skills enhancement training for 70,000 teachers, 1,200 facilitators and 3,500 school heads 1998-2003. It also provided "infrastructure in terms of Internet connections and e-mail addresses for all teachers and pupils." (Swedish government, 2004).

[24] Ibid: 5,250 billion Swedish kronor converted using 1 € = 9.47130 SEK. Source: The universal currency converter, http://www.xe.com/ucc/convert.cgi on 2005-07-03.

Figure 18. OECD broadband subscribers per 100 inhabitants, by technology, December 2004. Source: OECD (2004b).



A new bill on IT policy was presented to parliament in mid-2005 (see Swedish Government, 2005 for an overview in English). The bill, which seems likely to be accepted, proposes improved services for disabled and handicapped, a national healthcare database giving overview of patients, renewed competence development for teachers, grants for SMEs (~ € 3.2 million over five years), suggestions of common "e-signatures" for municipalities, county councils, and market actors, among many other things. This bill seems to deal more with detailed aspects than earlier bills. Less emphasis is put on distribution and infrastructure development, but more on contents.

Mobile Phones[25]

Sweden is a leading country in both the production of mobile phones (through the companies Ericsson and Sony-Ericsson) and their use, the latter shown by Table 21.

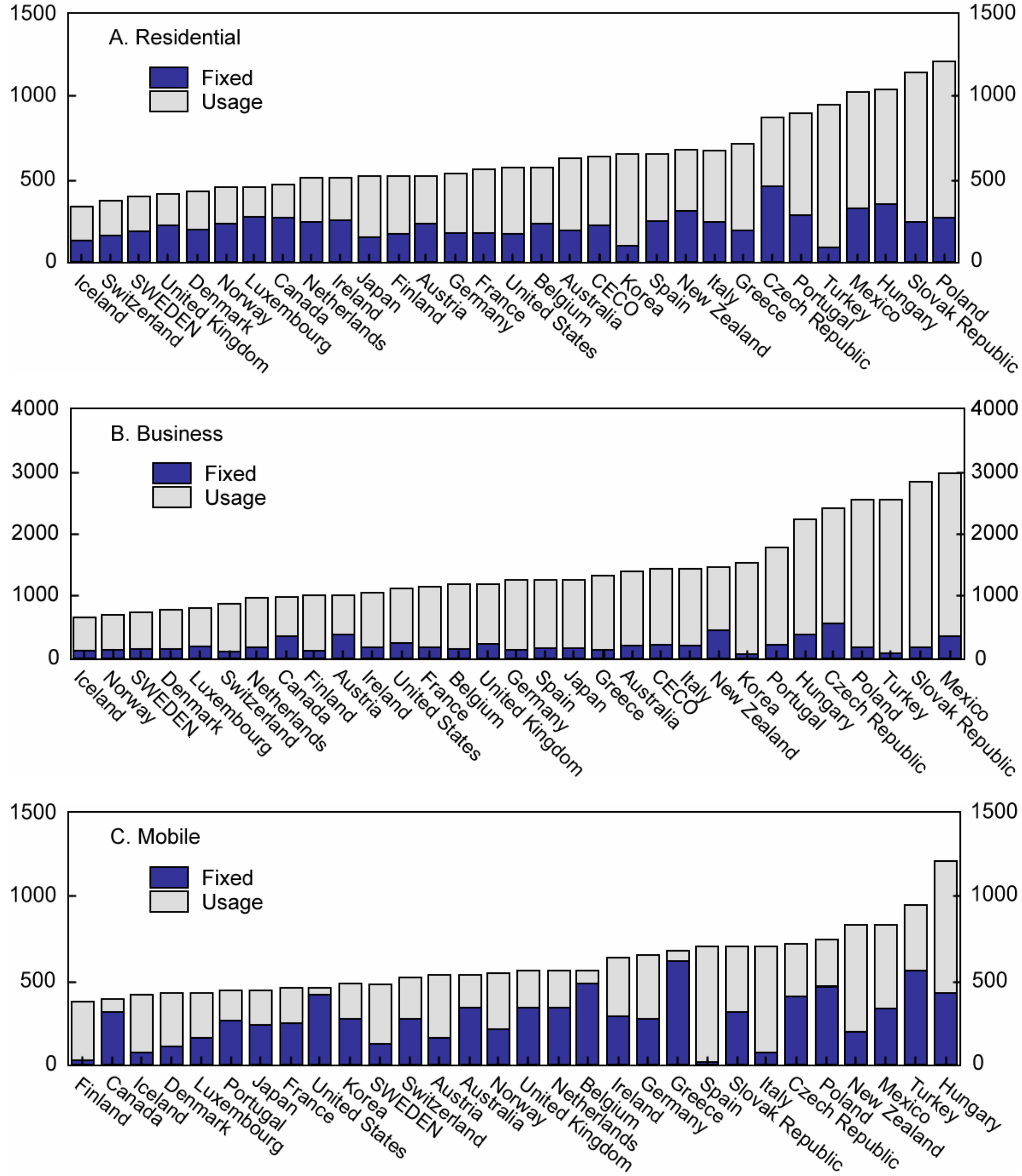
Table 21. Number of mobile phone subscribers per 100 people, 2002. Source: EU (2005).

Country	Number of mobile phones
Belgium (B)	79
Denmark (DK)	83
Germany (D)	72
Greece (EL)	85
Spain (E)	82
France (F)	65
Ireland (IRL)	76
Italy (I)	94
Luxembourg (L)	106
Netherlands (NL)	74
Austria (A)	79
Portugal (P)	83
Finland (FIN)	87
Sweden (S)	**89**
United Kingdom (UK)	83
United States (US)	49
Japan (JP)	64

Sweden was one of the first countries to deregulate its telecom market through the Telecommunications Act in 1993. The act was amended several times before the Electronic Communications act took over in 2003. In many respects the act has been successful in that Sweden enjoys one of the lowest rates on fixed telephone and business lines in the OECD area (OECD, 2004c), see Figure 19. Previously the rates for mobile telephony were quite high, but now the rates have dropped to the OECD average. Since an important element of the Swedish expansion into the third generation of mobile phones was that operators had to provide coverage of almost the whole country (99.9 per cent of residents should be reachable), infrastructure investments were associated with high fixed costs.

[25] This section builds extensively on OECD (2004c).

Figure 19. Telephone charges: composite basket of services for residential and business charges and "average user" basket for mobile charges. Source: OECD (2004c).



Conclusions

Sweden is a small open economy highly integrated with world markets with small barriers to trade and entrepreneurship. Yet, few businesses are started. The economy still hosts relatively large multinationals with large R&D capabilities, but they do not expand employment domestically. Also the higher education sector conducts much R&D. The output of the R&D system seems to be impressive; judging from patenting and research output (scientific journals) it seems to be highly productive. The quality of this research is much harder to assess. It seems that some output, e.g. the quality of publications in scientific journals in medicine, may have been deteriorating over time (Swedish Research Council, 2003). Increased transparency in terms of the productivity of researchers in academia would be valuable, not only in terms of scientific output, but also in terms of teaching and side-activities.

All in all, the Swedish system is heavy on the supply side of knowledge: The system yields many researchers and much output. More science and engineers come out of the university system than ever, despite popular belief to the contrary. Fundamental incentive structures are performing less well, however, as seen from the difficulties of the venture capital markets to foster new technology-based high-growth firms, and weaknesses in the return on investment in human capital. It is also important not to focus only on the university part of the education system. Payoff seems to be alarmingly poor from undergraduate education (gymnasium), which should be examined more closely.

In the present situation, additional disparate policy actions to stimulate clusters and private/public partnerships are unlikely to be effective. In any Swedish county, roughly 30 organizations are active in providing interfaces between actors in the innovation system (ITPS, 2004), yet relatively few fast-growing businesses are started. Given the scientific performance and high R&D-intensity of the Swedish economy, too few SMEs appear truly innovative.

Policy should therefore prioritize addressing the incentive structures for entrepreneurship, risk-taking, and academia. It should strengthen the institute sector and other intermediary actors in ways that enable them to more effectively bridge between business and the knowledge base. Universities also need to have more room for manoeuvre to specialize and prioritize, and encounter appropriate driving forces and mechanisms for diversifying away from dependency on the ivory towers of traditional academic structures, in order to leverage the transition to science-based economic growth. Above all, policy-makers should seriously address the problem that so few dynamic businesses have been started in the last decades, and especially by people with higher education.

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