Productivity growth and innovation in Switzerland – An international perspective

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Introduction

There has been renewed divergence of GDP per capita among OECD countries over the past decade: Whereas the relatively less advanced countries tended to catch up with the leader, the US, from the late 1940s to the late 1980s, the situation has reversed since the mid-1990s. Switzerland was not directly concerned by this process, as it has traditionally benefited from higher income than its European neighbours, but also than the US, during most of this period – it was being caught up rather than catching up; but Switzerland has been taken in a similar dynamics of slow growth as its European neighbours in the past decade.

GDP per capita results as the combination of two factors, productivity of labour and utilisation of labour (See OECD 2006, Compendium of Productivity Indicators). Productivity matters especially in the long run; it is the key to sustainable economic growth. Innovation in turn is a central factor of productivity growth. Assessing the innovation performance of a country, and explaining it, goes a long way to understanding the dynamics of its productivity, hence its economic growth. It is what this study will attempt to do, starting from GDP growth, going to productivity, to R&D, to innovation performance, and to the structural and institutional factors behind innovation.

This presentation follows up on a presentation made last year by the OECD at the Productivity Conference held in Madrid (Pilat 2005). In addition to focussing on Switzerland, this presentation, as compared with the 2005 one, essentially 1) updates the figures; 2) puts more emphasis on the central topic of this Bern conference, innovation and technical change.

The major OECD sources of data used for this presentation are as follows. First is the Compendium of Productivity Indicators (2006), just released by the OECD. The Main Science and Technology Indicators (MSTI) is the source for R&D data; the Compendium of Patents Statistics, to be released on October 23, is the source for patent indicators; and a few indicators have been obtained from the Going for Growth report published in May 2006.

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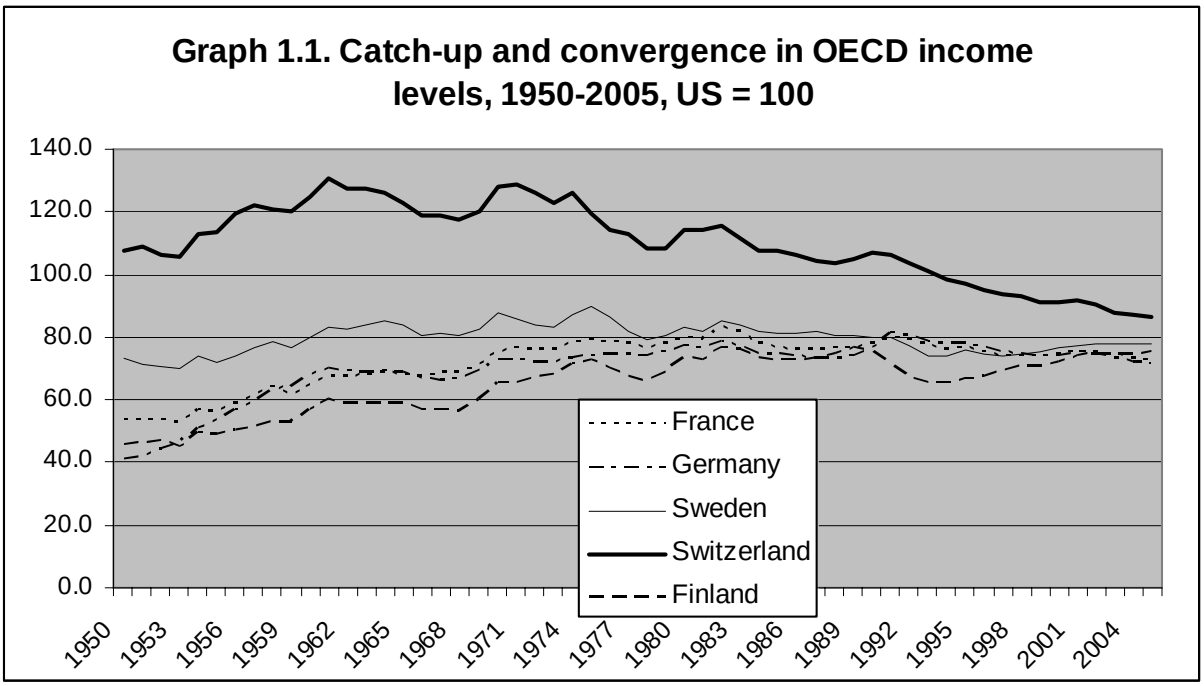
1) Productivity: General trends and determinants

There was catching up among OECD countries for several decades in the post war period, with convergence of GDP per capita of most OECD countries towards the US level. That meant relatively faster growth for most countries, which were initially lagging behind: But it meant relatively slower growth for Switzerland, which was initially ahead of the US (Graph 1.1). the level of GDP per capita is still very high now as compared with other countries, but it is not increasing very fast, a trend which, if continued in the future might create difficulties as population is aging.

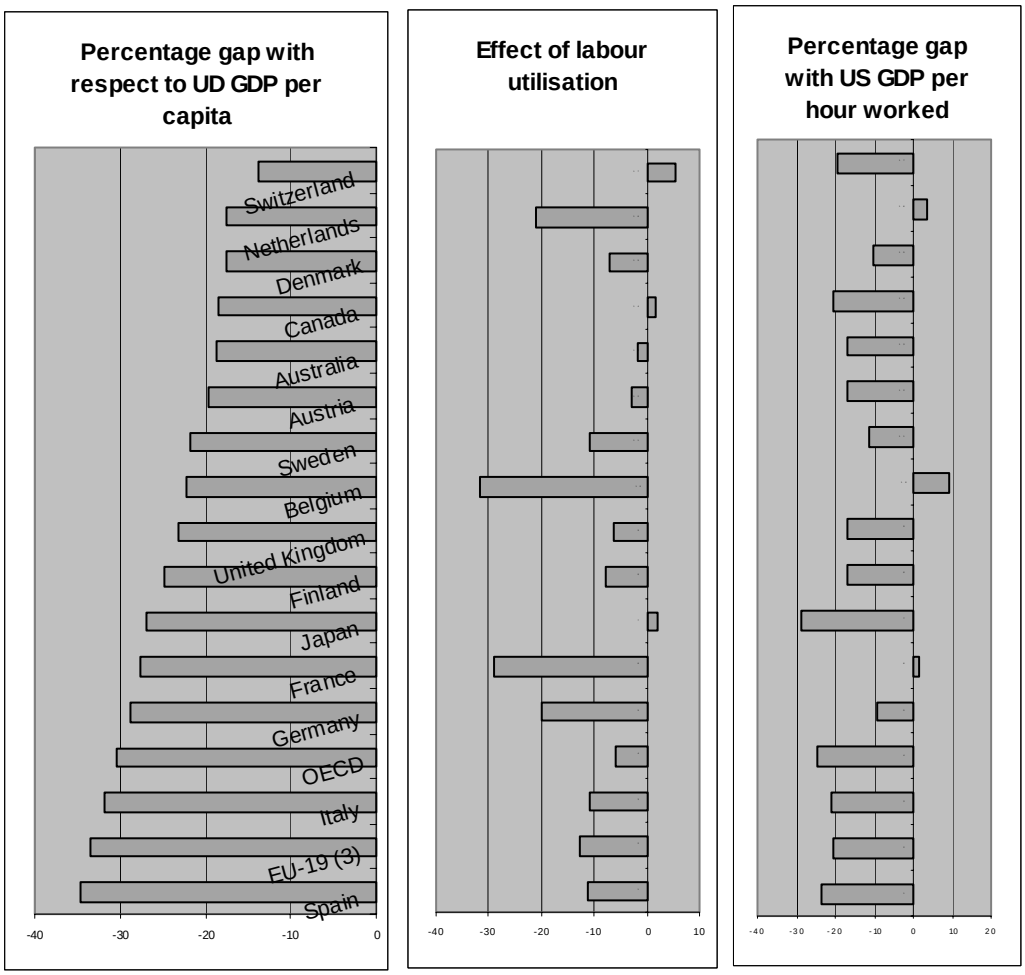


Source: Compendium of Productivity Indicators, OECD 2006

Looking at the 2004 levels in GDP per capita, which compare OECD countries with the US, in 2004 (Graph 1.2), Switzerland ranks fourth in OECD on that measure, after Norway, the US and Ireland. This has to be qualified, however, because there is a larger flow of net income into Switzerland, due to a good extent to Swiss corporations operating abroad. Thus, in terms of Gross National Income (GNI), the picture changes significantly, Switzerland receiving more transfers than it pays abroad (Compendium of Productivity Indicators, OECD 2006, graph B.3). However GDP per capita remains the key indicator of domestic activity.

GDP per capita can be broken down into two components: labour utilisation (number of hours worked per capita) and the efficiency of labour (GDP per hour worked, also labelled productivity of labour). Labour utilisation is high in Switzerland as compared with other OECD countries – Switzerland is third in OECD, after Korea and Iceland. Labour utilisation in turn results from three factors: average working time, labour force participation rate and unemployment rate). The high ranking of Switzerland in that regard is due to its very high labour force participation rate and very low unemployment rate, while working time is in the OECD average. By contrast with labour utilisation, the level of labour productivity in Switzerland is about the OECD average.

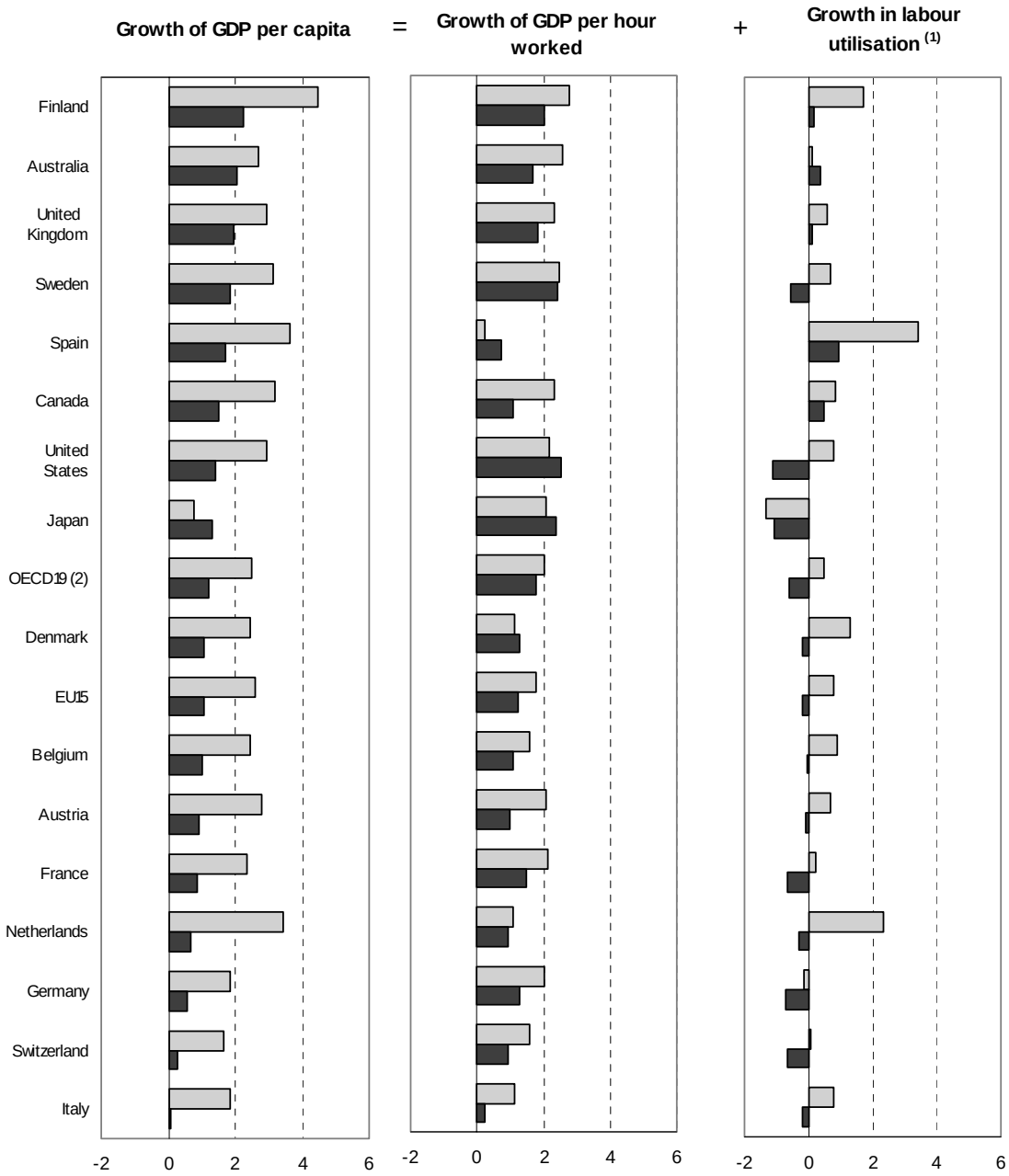
Graph 1.2. Income and productivity levels, 2005 | Percentage point differences with respect to the United States | Percentage gap in GDP per hour worked.



Source: Compendium of Productivity Indicators, OECD 2006

How has the situation evolved recently (Graph 1.3)? GDP per capita rebounded in most OECD countries in the mid-1990s, but more in certain countries (US, Finland, Spain, Sweden) than in others (Japan, continental Europe). In fact, Switzerland had the lowest GDP per capita growth of all OECD countries in 1995-2004, and just before Italy since 2000. The picture looks more favourable to Switzerland if growth in GNI is considered instead of GDP. Again, the growth of GDP per capita can be broken down into the two as components as its level. The acceleration of GDP growth in the US after 1995 was due to an acceleration in productivity, while labour utilisation kept constant. In other countries the dynamics of these two factors were different: In Finland and Sweden, productivity growth kept constant, while labour utilisation increased or did not change markedly over the decade. In Switzerland, productivity growth accelerated after 1995, but remained modest and slowed down again after 2000, while labour utilisation deteriorated slightly. Productivity growth in Switzerland has been similar to continental Europe, somewhere between Italy (down) and Germany or France (up).

Graph 1.3. Growth in GDP per capita - The contribution of productivity and labour utilisation (1995-2000, 2000-2005)

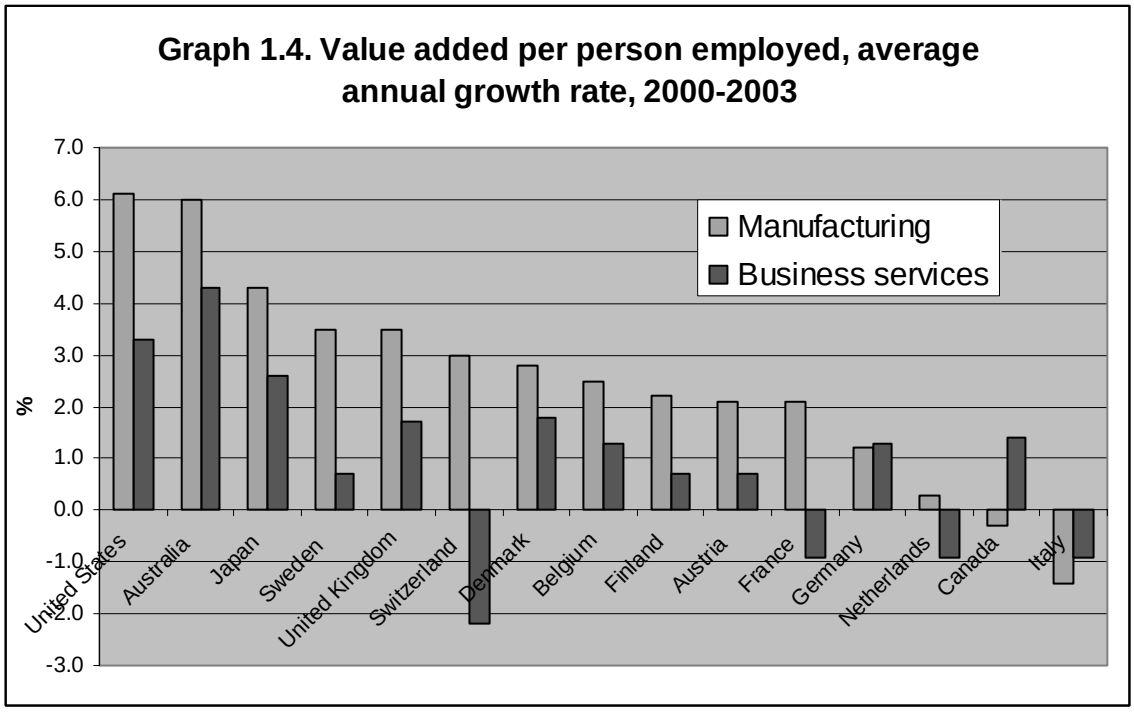


Source: Compendium of Productivity Indicators, OECD 2006

More insights into productivity are provided when looking at multifactor productivity (MFP) and at sectoral patterns. MFP growth in Switzerland, according to the figures just released by the Statistical Office, was of 0.9% per year in 1995-2000, and only 0.1% per year in 2000-2004. This is less than other OECD countries although available MFP figures may not be fully comparable with OECD data.

At the industry level, looking at labour productivity, Switzerland seems to have performed in the OECD average for manufacturing industries since 2000, which was a marked improvement as compared with the

1995-2000 period. By contrast, the performance in the business services seems to have been the worst of all OECD countries since 2000, whereas it was modest but not far below the OECD average in 1995-2000.



Source: Compendium of Productivity Indicators, OECD 2006

Conclusions:

- Switzerland used to be at the top of the OECD league in terms of GDP per capita. It is still very well placed, but it has progressively lost ground over the past two decades. While labour utilisation is high, the productivity level is now just average and is increasing slowly.
- Various statistical and macro-economic factors can be invoked. For instance the high share of services in GDP, notably financial services, a sector where productivity measurement is relatively weaker, which could result in underestimating aggregate Swiss productivity performance. Switzerland might have also suffered from the fact that its closest neighbours, which are also among its major trade partners, notably Germany and Italy, had very modest growth over the past decade. But such factors cannot account for such a long term and structural trend as the slow productivity growth in Switzerland.
- Productivity performance depends on the technology used and the value-added contents of activities in which the country is more active. Slow growth of productivity could come from the slow adoption of new technologies, and/or from insufficient development of higher value added activities, such as R&D, high tech industries and services etc. It is through innovation, notably technological innovation, that a country can achieve and maintain a strong position in such activities.

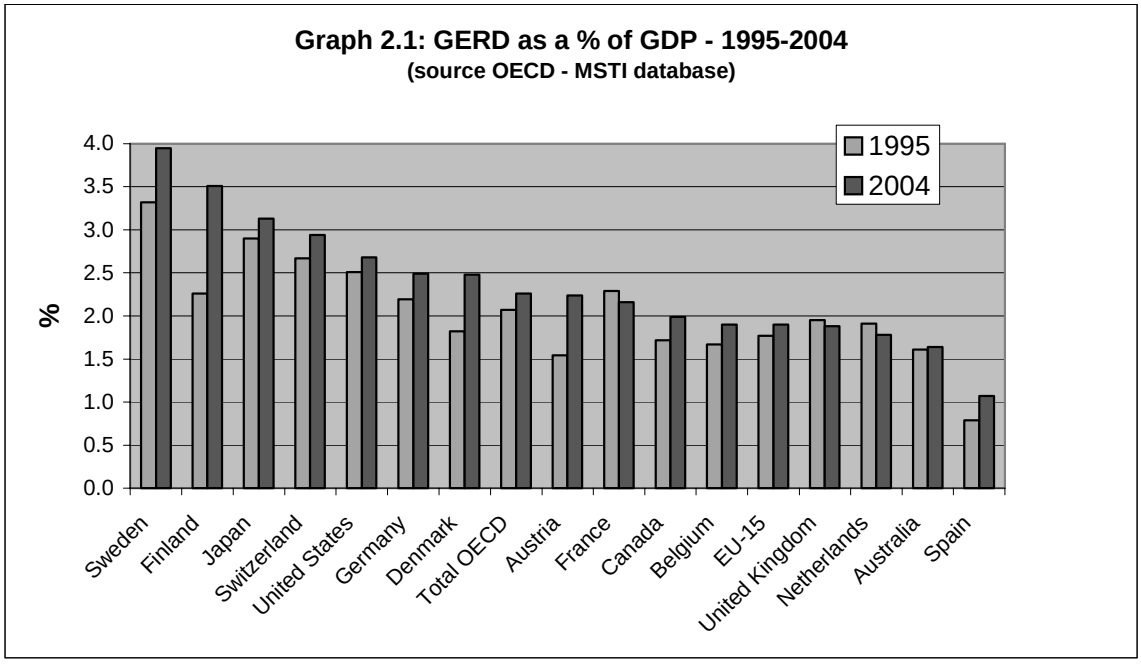
In the rest of this presentation we will focus on technological innovation, generated notably by R&D, examining both its most salient features in Switzerland and its major determinants.

2) Patterns of innovation

Innovation occurs when new ideas or inventions are put into use, so as to enhance productivity or the quality of goods and services. Innovation not only increases directly economic efficiency, but it also creates investment opportunities which translate into further economic growth via the accumulation of capital. It has been long established that R&D is a major source of technological innovation and in turn of productivity growth (Guellec and van Pottelsberghe 2004).

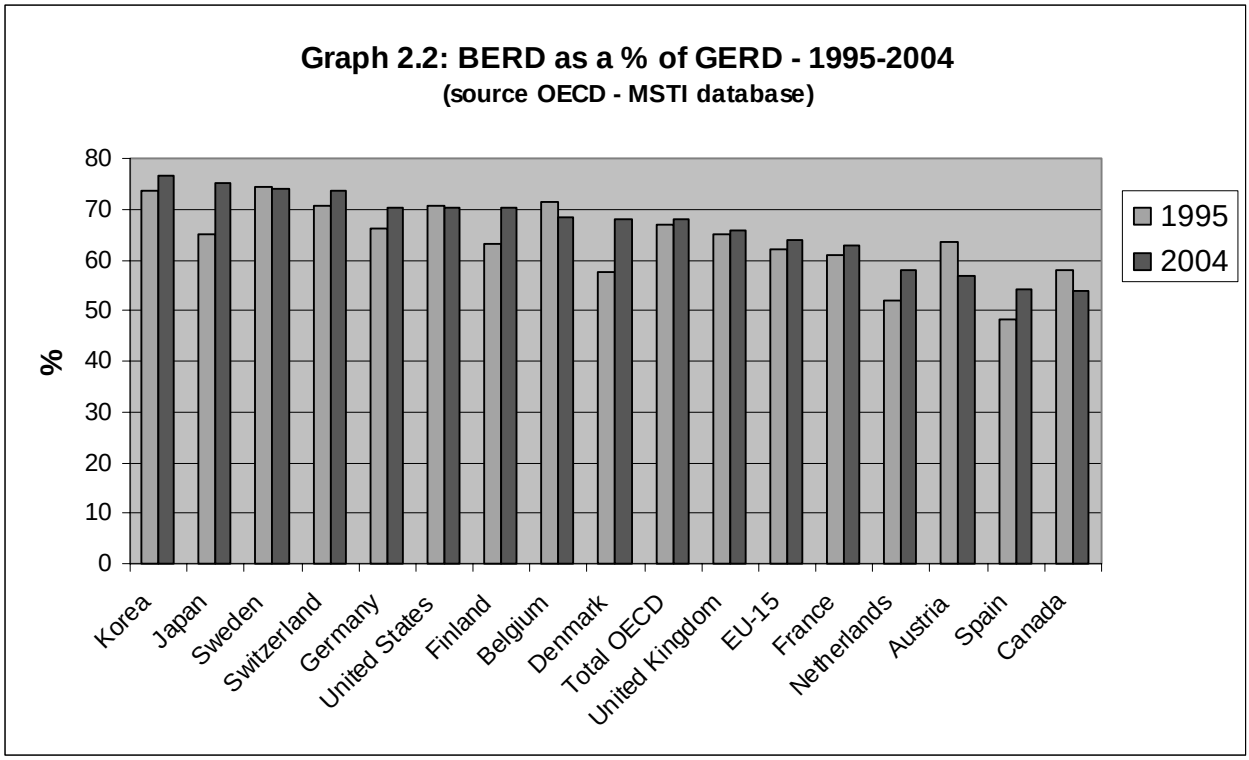
Innovation is of particular interest to government as it is seen as an area where policy can have a significant impact. Knowledge is partially a "public good", subject to market failure (the competitive mechanism results in under-investment in new knowledge, due to partial appropriation of the social return and to high risk); hence the importance of government in this area: for providing adequate funding, but also, and sometimes mostly, to provide adequate institutional conditions which will give business a sufficient return on investment. That includes IPR, competition policy etc.

In view of the perceived increase in the economic importance of innovation and new knowledge as a determinant of economic growth, it has become a priority for economic statisticians to develop relevant instruments and a proper framework for measuring its size and impact. We use input measures (notably R&D) and output measures (e.g. patents).



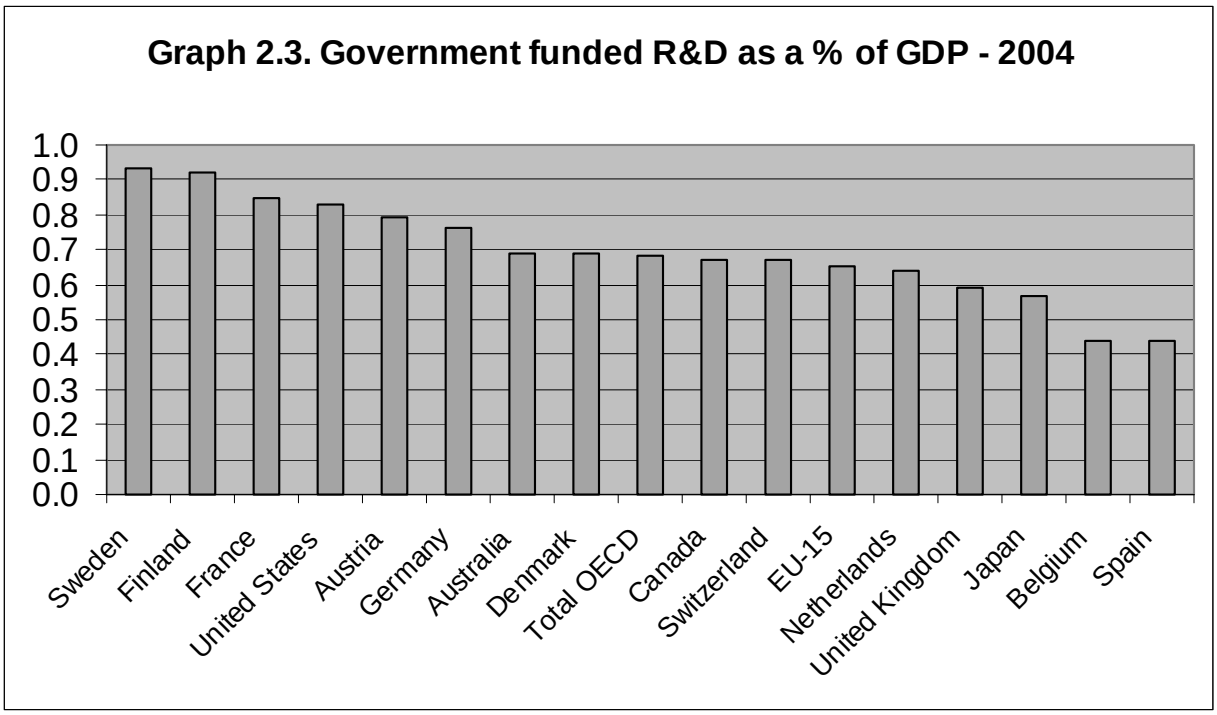
Source: Main Science and Technology Indicators (MSTI), OECD 2006

R&D intensity, the ratio of R&D expenditure over GDP, is the most often used measure of technological effort (Graph 2.1). Switzerland features extremely well in that regard, being the 4th among OECD countries (after Sweden, Finland and Japan) with an intensity of almost 3% in 2004 as compared with an OECD average of 2.25%. In addition, the R&D intensity of Switzerland has progressed in line with the rest of OECD over the past ten years, although in a context of much slower GDP growth.



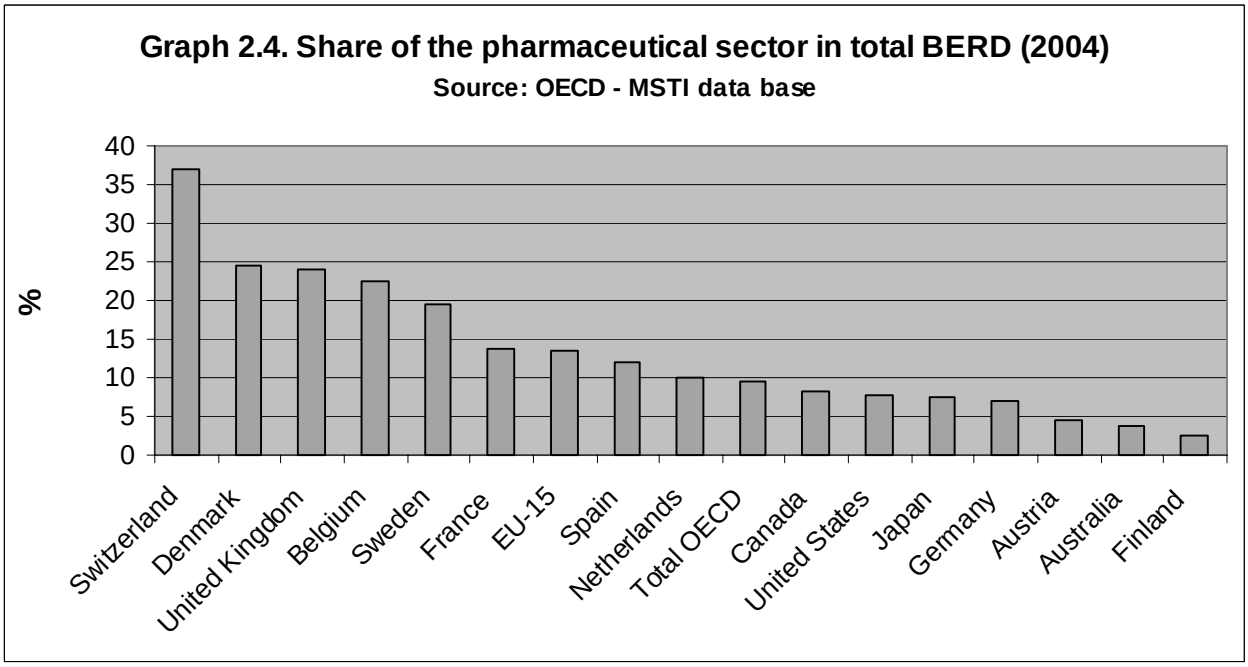
Source: Main Science and Technology Indicators (MSTI), OECD 2006

R&D can be performed by business (it is then called BERD), by government or by universities. Hence the Lisbon objectives of the EU include not only a global figure (the often mentioned "3 %"), but also a key for the breakdown between government (1%) and business (2%). The share of business in total R&D is higher in Switzerland than in most other countries (the same level as Sweden in 2004, about 75%, against an OECD average of 68%), reflecting a favourable business climate (Graph 2.2).



Source: Main Science and Technology Indicators (MSTI), OECD 2006

On the other hand, the share of government R&D in GDP is almost 0.7% in Switzerland (Graph 2.3). This is close to the OECD average, but it is much lower than in comparable countries like Sweden or Finland where it is more than 0.9%.

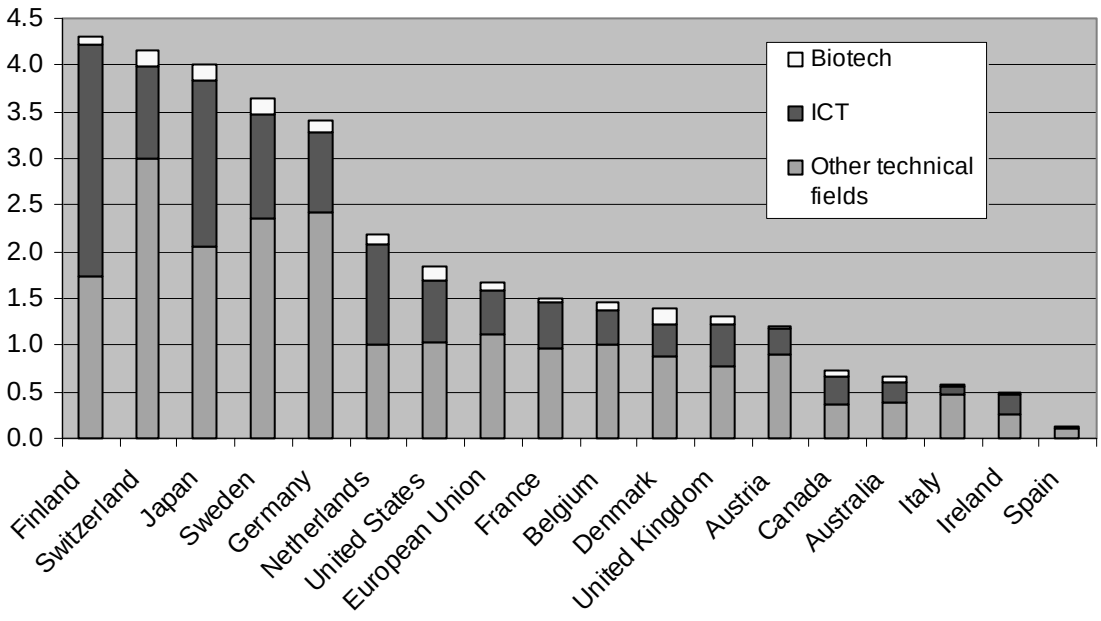


Source: Main Science and Technology Indicators (MSTI), OECD 2006

The high R&D intensity of Switzerland reflects partly the industry specialisation of the country, which is oriented towards pharmaceuticals. The pharmaceutical industry is among the most R&D intensive ones and

it has a high share in the Swiss industry: It represents 37% of Swiss business R&D, against an OECD average of 19% (Graph 2.4). Such a high degree of specialisation reflects also the relatively small size of the country: in an age of globalisation, specialisation is inevitable – e.g. Finland with the mobile telecoms. It is not necessarily a bad thing, as it can be a source of efficiency (economies of scale). It allows countries to reinforce their comparative advantages. Specialisation in pharmaceutical is not bad also as it is an area where demand will continue to grow, with healthcare being a rapidly growing share of GDP, due to the increasing wealth and ageing of most countries in the world.

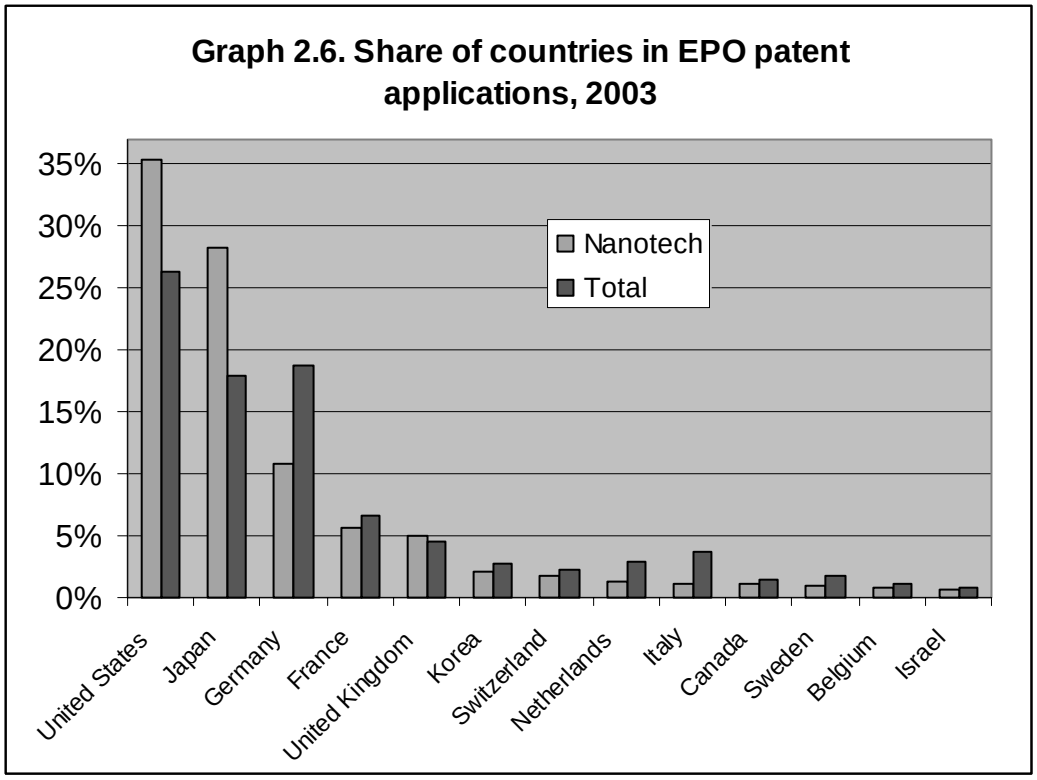
Graph 2.5. Patenting intensity by technical fields (number of patent families over GDP, 2002)



Source: Compendium of Patent Statistics, OECD 2006

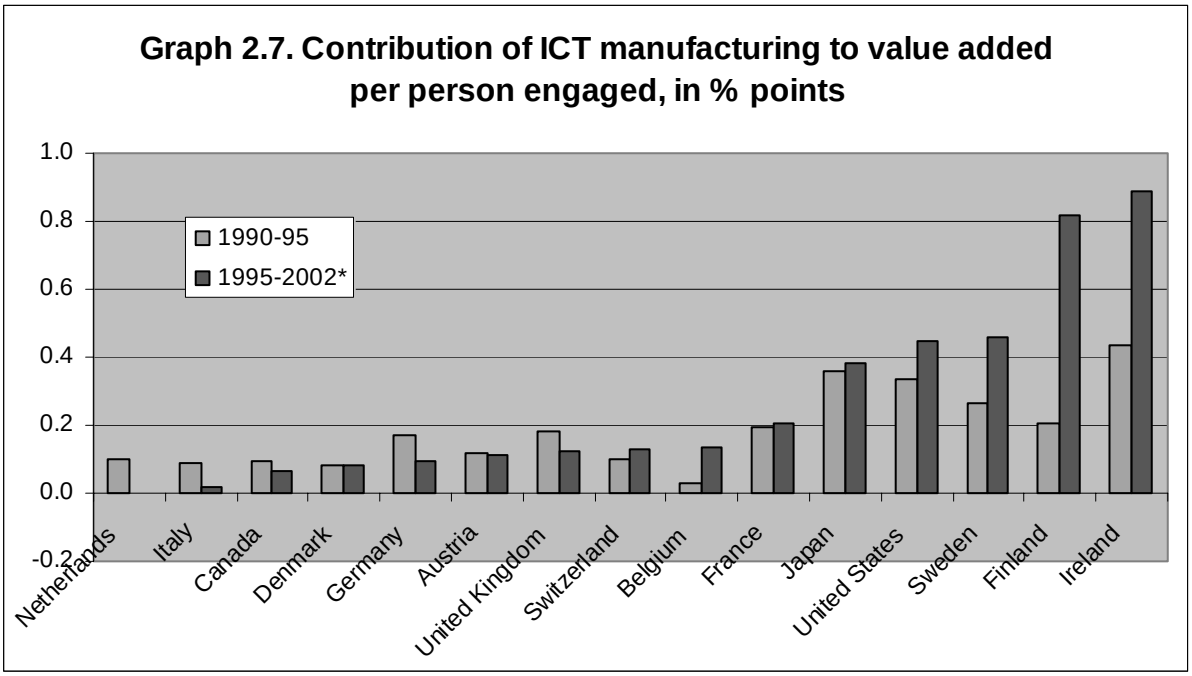
What does this considerable investment result in? Measuring the output of technological innovation can be done with patents. The statistical properties of patents as indicators of technical change have been well identified (OECD 2006, Compendium of Patent Statistics). The indicator used here is "patent families", which are inventions protected altogether in Europe, the US and Japan. They are not subject to the "home bias" which affects all national patent data, and they leave aside inventions with low economic value. The patent count is divided by GDP, so as to normalise the indicator (Graph 2.5).

Switzerland is ranked second in the world, very close to the first (Finland) which makes it obviously a high achiever. It was first in 1991. This performance reflects partly the specialisation of the Swiss industry in pharmaceuticals, a sector with high propensity to patent its inventions. The small progress of Switzerland since 1991 is to be contrasted with the sharp increase in Finland or Sweden, for instance, countries with high specialisation in ICT (which accelerated its technological progress and patenting activity in the 1990s).



Source: Compendium of Patent Statistics, OECD 2006

Despite its high overall performance, Switzerland has a relatively poor record in new, emerging sectors. This holds for ICT, but also more surprisingly for biotechnology, which represents less than 6% of filings to the PCT (an international type of patent) by Swiss residents, against more than 7% for the OECD average. This is surprising in view of the specialization of Switzerland in pharmaceuticals. With 8.6% of its business R&D in biotech fields, Switzerland is among the highest OECD countries (Source: Compendium of Biotechnology Statistics, OECD). However, this is not in line with its outstanding share in pharmaceuticals. When looking at another emerging field, nanotechnology (Graph 2.6), the same pattern emerges: Whereas the share of Swiss inventors in applications to the European Patent Office was overall 2.3% in 2003, their share in nanotechnology related fields was 1.7% only. Hence, the strong overall technological performance of Switzerland seems to be attached with more traditional fields, with a relative weakness in emerging ones.



Source: Compendium of Productivity Indicators, OECD 2006

Another angle for analysing the technological performance of a country is to look at the share of particular industries, the most innovative ones. The contribution of ICT manufacturing to productivity growth has been considerable in a number of OECD countries, due both to rapid productivity growth in ICT producing sectors (the "Moore's law") and to an expansion of those sector relative top the rest of the economy.

Graph 2.7 shows the contribution of ICT manufacturing industries to aggregate labour productivity growth. Switzerland ranks in the middle of the "continental European" pack, between France and Germany, far from the top countries (Finland, Hungary, Ireland, Japan, Korea and the US). This is related notably to the low share of ICT manufacturing in the Swiss industry.

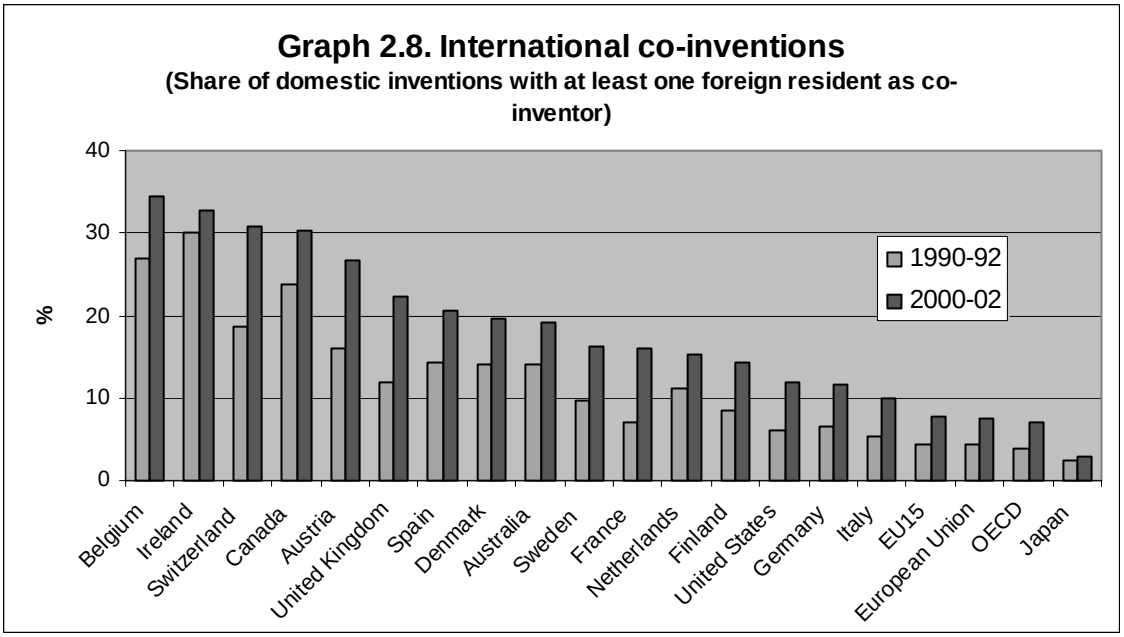
The importance of openness for economic growth is due to several mechanisms, such as increased competition, the ability to specialise and benefit from economies of scale, but it is all the more important in the field of technology. For all countries foreign sources of knowledge have a major impact on MFP growth, due notably to the public good nature of knowledge. This is all the more true for smaller countries, which cannot invent everything themselves (Guellec and van, Pottelsberghe 2004). In addition, the impact of foreign R&D on domestic productivity is higher in countries which do themselves much R&D. Foreign knowledge can be accessed in different ways. Research co-operation (i.e. research projects involving both domestic and foreign researchers) are one way; the creation of foreign research facilities by domestic multinational firms, or of domestic laboratories by foreign multinational firms are also vehicles of knowledge.

International linkages can be measured through patents, as patent filings include the address of the owner(s) as well as of all co-inventors. The share of inventions involving co-inventors located abroad (outside Switzerland) is very high (Graph 2.8), showing that Swiss laboratories are active on the international market for research. The share of inventions made abroad in the total of inventions own by Swiss companies (Graph 2.9) is very high as well, reflecting the globalisation of research activities of

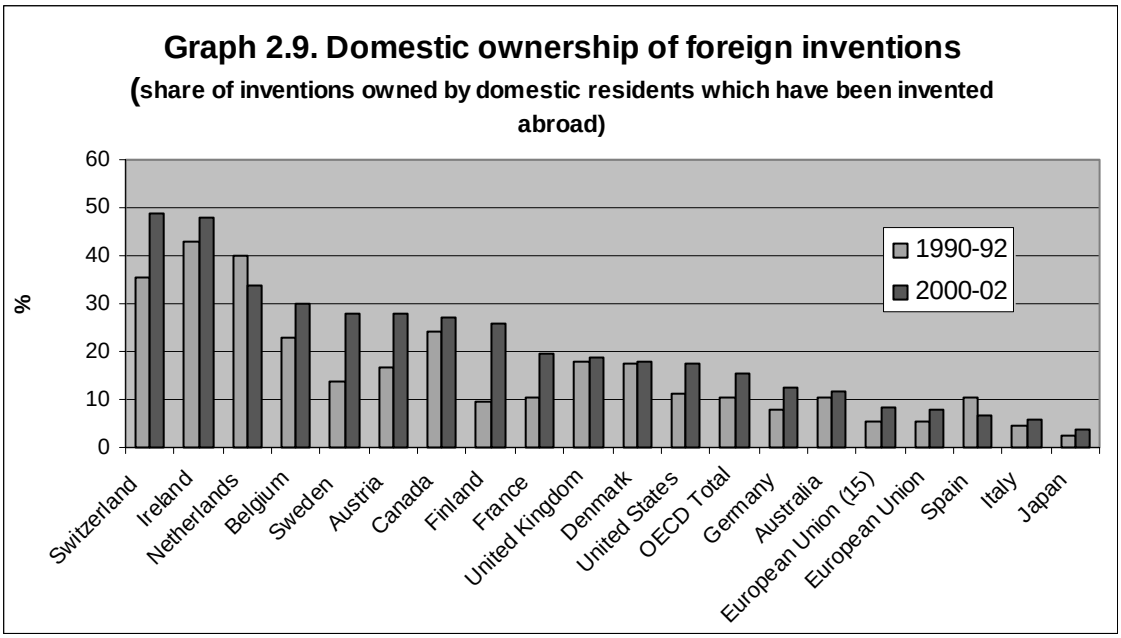
Swiss firms, notably in the pharmaceutical sector. These indicators show that Switzerland is much internationalised in the area of technology. This holds still when controlling econometrically for certain characteristics of the country (size, R&D intensity) as was done in Guellec and van Pottelsberghe (2001b). In contrast, foreign ownership of domestic inventions is relatively low (i.e. in view of other indicators, one would expect it to be higher), Switzerland being far behind other countries like Belgium or even France (Graph 2.10). This reflects the fact that relatively few foreign firms have research facilities in Switzerland. Is the Swiss research system relatively little attractive, or is it rather closed to foreigners? This point certainly deserves to be investigated in view of the importance of R&D related foreign direct investment (FDI) for the emergence of new industries (bringing in the country new knowledge and new competition to established industries).

Graph 2.8. International co-inventions

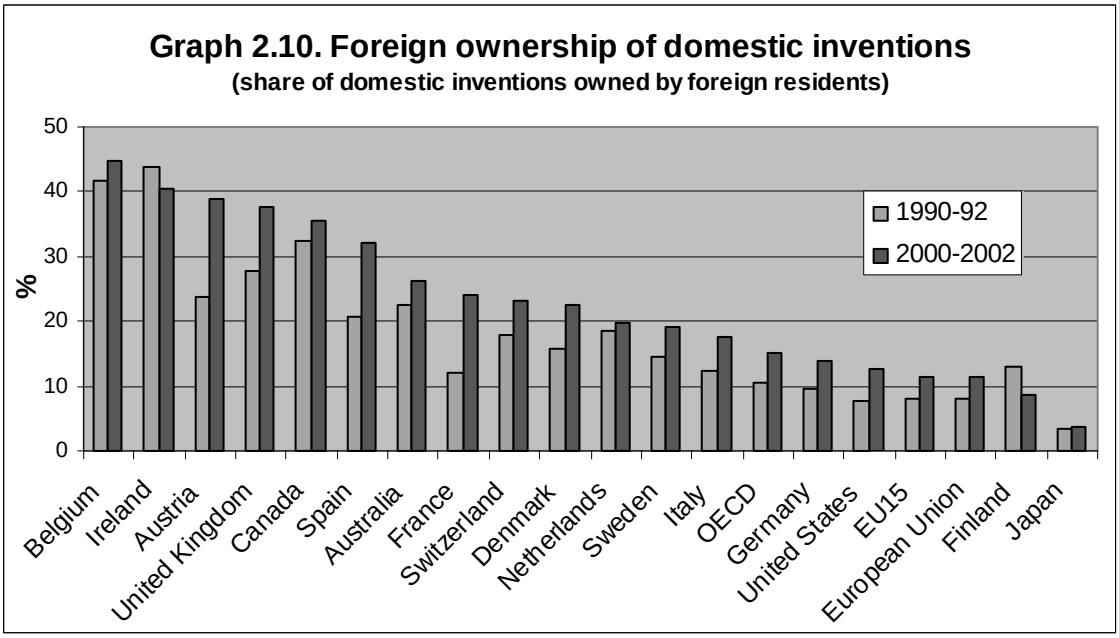
(Share of domestic inventions with at least one foreign resident as co-inventor)



Source: Compendium of Patent Statistics, OECD 2006



Source: Compendium of Patent Statistics, OECD 2006



Source: Compendium of Patent Statistics, OECD 2006

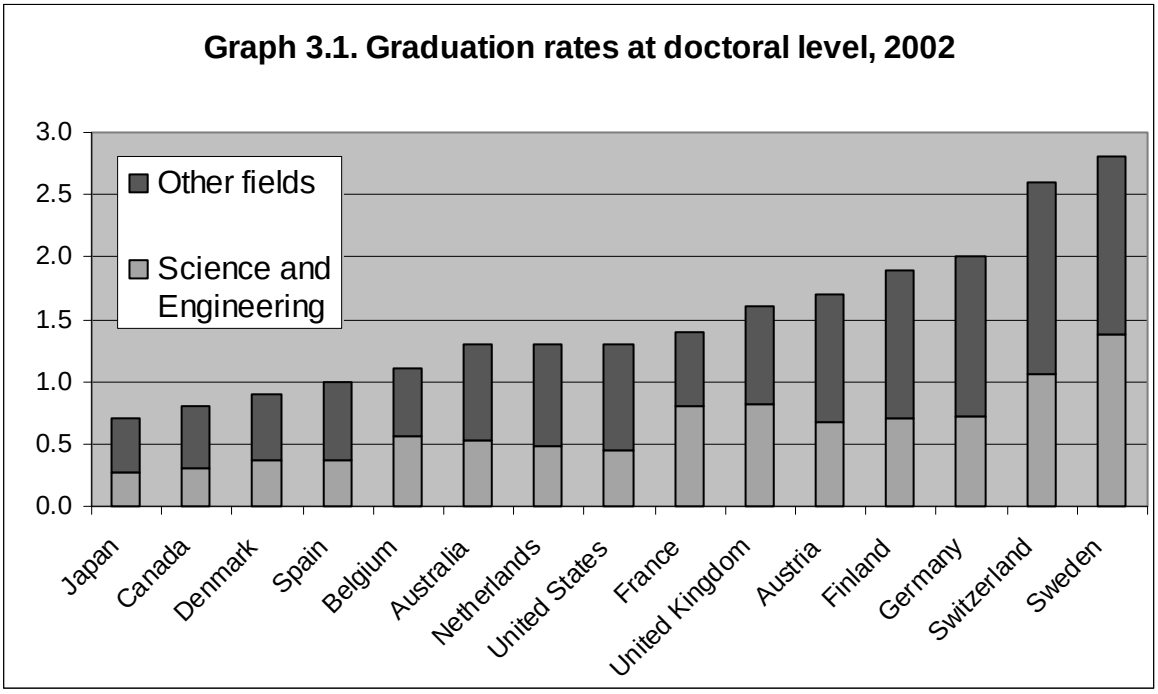
The analysis above tends to show a relative difficulty of the Swiss economy to develop new, emerging industries like ICT, software, biotechnology, nanotechnology. The third section of this study will attempt to understand the reasons for that.

3. The insufficient development of new activities

Productivity change at an aggregate level occurs notably by the expansion of new industries, with higher rates of innovation and knowledge contents. Such industries include nowadays biotechnology or ICT, also characterised by certain scholars as "generic technologies" as their progress tend to diffuse in most other industries. The emergence and expansion of new industries depends notably on:
1) The availability of the needed factors, mainly skilled labour, knowledge (science), and capital;
2) The incentives and institutions that will drive these factors into new industries. That includes competition and openness of markets for goods and services and of the labour market, as well as adequate incentives for capital to go into risky areas, incentives for university knowledge to be poured into the industrial sector.

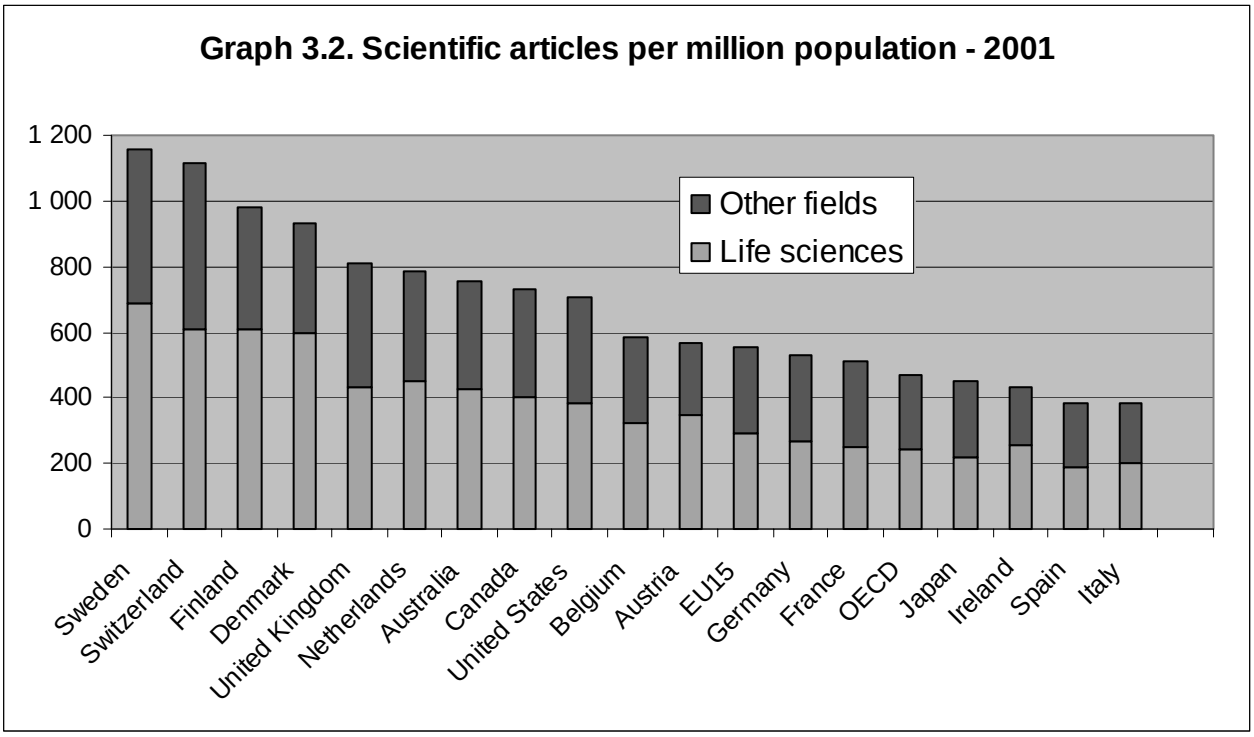
The first aspect refers to the availability of resources, the second to their allocation. The latter aspect is closely related to the issue of entrepreneurship, as new enterprises are the major vector of emerging industries. We will now review the availability of factors and their allocation to new activities.

Lack of skilled labour in the S&T fields is apparently not a problem in Switzerland. The university system produces many highly skilled workers in the S&T fields. Switzerland ranks second in OECD in terms of graduation rate at doctoral level (share of an age cohort who performs a PhD), be it in the Science and technology fields or overall, just after Sweden (Graph 3.1).



Source: Education at a Glance, OECD 2006

Nor is there lack of basic knowledge. Measured by the share of articles with Swiss authors in scientific journals (Graph 3.2), the presence of Swiss science in the world is considerable: Switzerland ranks second again, just after Sweden and immediately before Finland. Universities and public laboratories, which are the major source of such knowledge, produce much new knowledge of high quality. One must control however for the CERN factor (an international organisation of extremely large size, publishing a lot, and based in Switzerland but which is not really reflective of the Swiss scientific system). By keeping to life sciences we exclude most of CERN publications, and Switzerland still features next to the top.

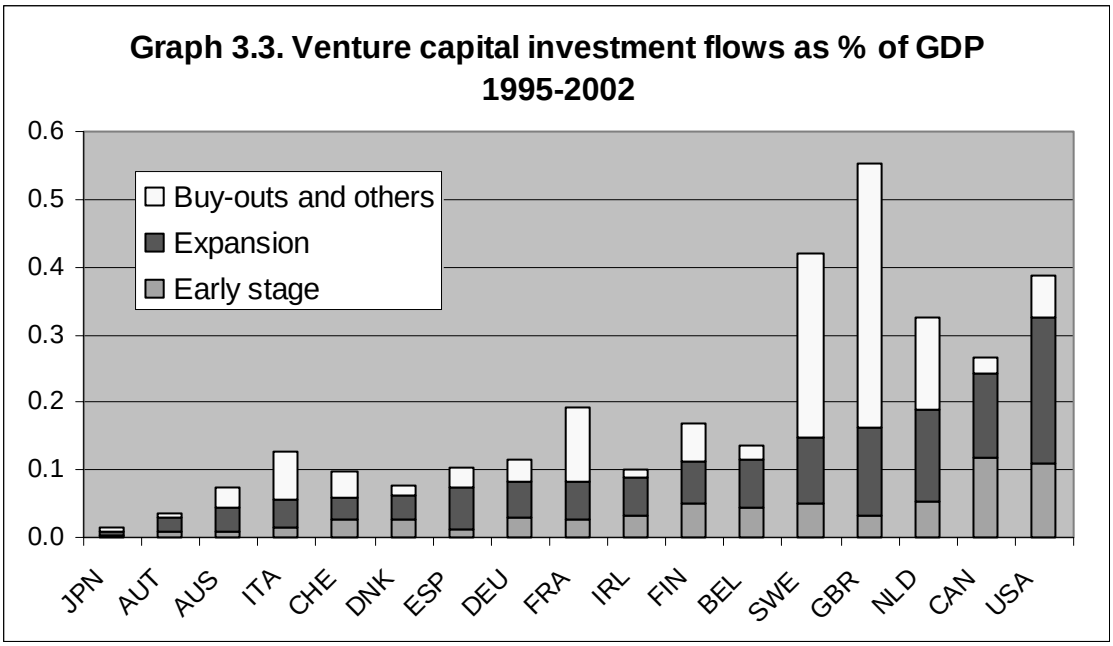


Source: STI Scoreboard, OECD 2005

Lack of capital should not be a problem for an industrialised country in a world of globalised financial markets.

Hence there is no shortage of factors that could feed in the development of new activities. What about the allocation of these factors?

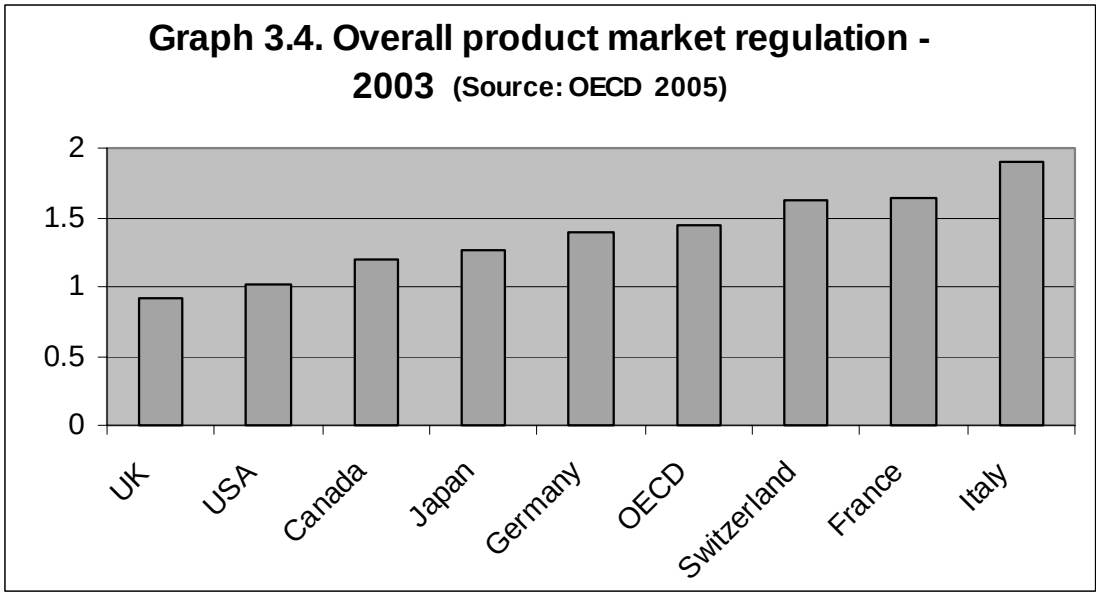
Capital is allocated to emerging activities mainly through venture capital (VC). Such activities are typically developed by new firms, with high risk and high reward. VC has permitted the creation of nearly all successful companies in new industries since World War 2, including Intel, Microsoft, Chiron etc. All prominent internet or biotech start ups have started with VC funding. The share of capital allocated by VC funds is relatively low in Switzerland, especially in view of the high R&D expenditure of the country (Graph 3.3). It is even lower if one keeps to the early and expansion stages, the most risky ones in the life of a business. Countries like the Netherlands, Sweden or Finland have a much higher share. Swiss industry has been traditionally funded on bank loans and internal funding from cash flow. Large, established firms will tend to fund new activities which are in line with their current business, not those which might disrupt it or cannibalise it. Banks are ill-equipped for managing the specific risk patterns of emerging industries, and they are limited by strict prudential regulations. It is therefore not expected that entirely new activities are started by large, established firms or funded by banks. It has been clear for instance that biotechnology was developed by specially established firms, which would then (when being successful) possibly be acquired by pharmaceutical companies as a way for these companies to access biotech knowledge and implement it in their mainstream activities (developing new drugs, tests etc.). Most biotech firms were created in the US and secondarily in the UK, whereas continental Europe was not extremely successful (despite significant achievements, like in Bavaria). Hence, Switzerland in this regard is quite conform to neighbouring countries.



Source: OECD Venture capital database. Going for Growth 2006.

The weak development of VC in Switzerland is probably one factor which explains the difficulty of nurturing new industrial activities. It might not be due to financial reasons, or supply side factors only however. Demand for VC depends on entrepreneurship, and it is affected by the broader conditions given to entrepreneurship, such as bankruptcy laws (which influence the distribution of risk between entrepreneurs and fund providers), market openness to new entrants (competition law, public procurement etc.), and by labour market regulation (which command the possibility and cost for new firms to attract and lay off staff).

Product market regulation in Switzerland is more restrictive than in most other OECD countries (Graph 3.4). This might be less of a problem for large Swiss firms, notably in the pharmaceutical industry, as they compete on international, world-wide markets and as they have the resources to cope with regulation. But it can be a problem for start ups, which often initially target the local market or are in any case subject to national regulation, and for foreign companies which are not necessarily equipped to cope with specific national regulations.

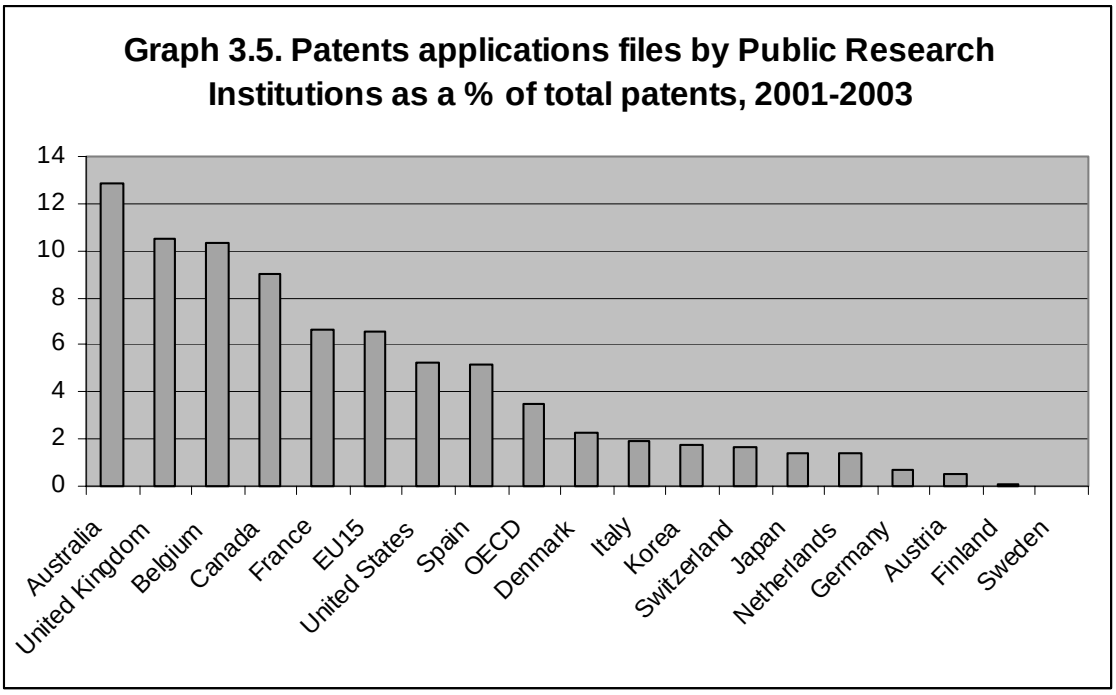


Source: Going for Growth, OECD 2005

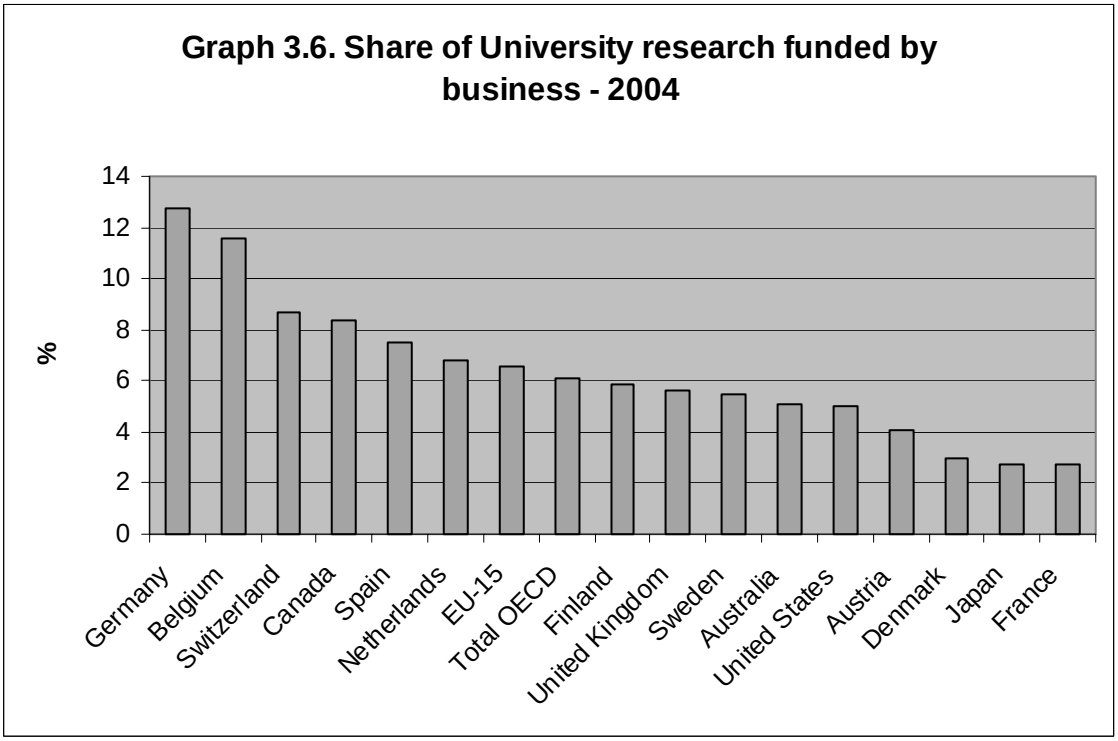
Swiss universities produce much valuable knowledge, but to what extent does it flow to industry? Knowledge transfers from university to industry can take several channels. Over the past 25 years, starting in the US and then coming to other OECD countries, universities have patented more and more of their inventions. Provided that this is well monitored so as not to hamper the mission of university of disseminating knowledge among the public, patenting is usually viewed as encouraging the downstream exploitation of inventions, notably by spin-offs and other start-up companies. Most entrepreneurs will not engage in costly downstream investment if they are not guaranteed some exclusive rights on the product they are developing on the basis of fundamental knowledge provided by universities. The share of universities in patents filed by Swiss applicants to the EPO is significantly lower than the OECD average. The legal framework might be responsible for that (in certain countries like Sweden, or Germany until recently, the ownership of inventions performed in universities would remain with the inventors).

Another channel for knowledge transfers is to conduct joint research projects, where often the business part provides the funding while the research is done by university staff. This mechanism is reflected in the share of public research funded by business (Graph 3.6). This share is of 8.5% in Switzerland, which compares to 6% in OECD and 5.5% in Sweden. That shows that businesses have developed active links with public research. That finding does not conflict with the weak number of patents taken by universities: First, usually patents resulting from joint university-business research are taken by the business partner, which compensates accordingly the university side. Second, businesses which fund university research are usually large, established ones, of which Switzerland has plenty; by contrast, the role of university patents is to encourage spin offs, i.e. the creation of new businesses, which is quite weak in Switzerland.

Overall, it seems that the Swiss institutional context is extremely effective for supporting the development of established businesses, including in high technology fields, but it is quite unfavourable to for entrepreneurship: the financial system, market regulation and university-industry links do not seem to encourage the creation of new firms in emerging industries.



Source: Compendium of Patent Statistics, OECD 2006



Source: Main Science and technology Indicators (MSTI), OECD 2006.

Conclusions

Switzerland has a high labour productivity level, commensurate with the good performance of its industry in established sectors, including knowledge intensive ones like pharmaceuticals or financial services. However, Switzerland experienced relatively slow productivity growth over the past decades. One reason is the weakness of emerging industries in the Swiss economy. New activities such as biotechnology or nanotechnology develop mainly with start ups. The conditions for the creation of new firms in Switzerland are not as favourable as they could be. In order to enhance entrepreneurship, hence fostering new, knowledge intensive sectors, a series of policy orientation have to be explored, as mentioned in the recent OECD report "Going for Growth" and in the 2006 OECD Country report on Switzerland:

- ***Reduce barriers to domestic competition***
  Pursue efforts to reduce market segmentation and foster competition by revising the domestic market law, removing administrative and technical barriers to imports and reducing administrative burdens on firms.

- ***Improve efficiency of public support for R&D***
  While maintaining strong support for fundamental research, better bridge the gap between it and product/process development by increasing the resources of the Commission for Research Co-operation between universities and businesses.

- ***Raise efficiency of bankruptcy procedures***
  Reform the bankruptcy law to reduce the period over which creditors can make claims on owners who had – when launching their company – to accept personal liabilities for credits obtained, and to facilitate the use of the *concordat* procedure.

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