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International aspects of Swiss research and development in 2008

From the internationalisation of enterprises to international public cooperation

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1 Introduction

1.1 Background to the study

For nearly twenty years, the terms "globalisation" and "internationalisation" have been used in common parlance. The media regularly report on the expansion of markets abroad, the establishment of new subsidiaries abroad and the volume of international trade.

The expansion of multinationals across national borders has become commonplace in recent years primarily due to World Trade Organisation (WTO) agreements signed in the 1990s, which have encouraged free trade.

The upshot of this has been to make the internationalisation of enterprises easier. In other words, it has allowed companies to become established on foreign markets, either to gain access to new markets or to enjoy the possibility of lower-cost production.

While internationalisation is now well known in industries such as textiles and clothing, it remains little known in the area of corporate research and development (R&D).[1] In the past, enterprises often preferred to set up their research centres in their own country in order to have better control over this type of strategic activity. But this attitude is changing and R&D activities are becoming increasingly international.

It is worth noting that the international exchange of knowledge does not only take place in the private sector. It also happens in the public sector. In fact, states do not generally have sufficient resources to ensure the competitiveness of their economies on the international stage on their own. Consequently, the fragmentation of research at national level prevents Europe from achieving its full potential in research and innovation. To overcome this obstacle, several international organisations and research programmes have been established. For example, the European Council has created the European Research Area (ERA). But the context is different from that of enterprises. In the public sector, the primary goal of R&D is not to make a profit or gain a leading technological position. On the contrary, the aim in this case is to enable all economic actors to benefit from disseminating the research results obtained as widely as possible so that everyone can benefit from the latest technological developments.

In the case of a country, internationalisation of R&D can be analysed, on the one hand, in terms of the transfer abroad of national R&D and, on the other, in terms of the penetration and assimilation in its territory of R&D from abroad.

Every actor in the field of R&D is always faced with the dilemma of either inventing or obtaining from third parties technologies needed for its own R&D activities. From an enterprise's perspective, using third parties makes it possible to acquire technology more easily, but it does not necessarily encourage the enterprise to develop its own technology. From the state's perspective, using imported technology means being able to rely on a workforce that can easily integrate and adapt to new technologies. At the same time, importing technology involves a risk of dependency, which is why countries seek to develop through their R&D activities their own innovative technologies to promote a certain degree of technological independence.

[1] According to the internationally established definition, research and development "… comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge … and the use of this stock of knowledge to devise new applications." For more information, refer to the Frascati Manual, OECD, 2002, §63.

1.2 Aims of the publication

In recent years public interest in this phenomenon has been growing, given the scale of the development of R&D abroad. There is a growing concern and even fear among the general public that R&D activities abroad are gradually replacing R&D activities in Switzerland. To be able to formulate policies and make strategic decisions, both the Swiss Confederation (federal administration) and enterprises require a good understanding of this trend.

In this context, the Federal Statistical Office (FSO) is publishing for the first time an analysis dealing exclusively with the international aspects of R&D. Some aspects have been discussed in publications on the results of R&D surveys[2]. But this subject has not been previously examined specifically in a single conceptual framework.

This publication aims to analyse the results of R&D surveys to shed light on the situation in Switzerland in this area compared with the rest of the world.

With the aim of being as comprehensive as possible, the focus of this publication is not solely confined to measuring in a conventional way the internationalisation of private enterprises' R&D activities. It also addresses the subject more broadly, examining various forms of R&D exchange across Switzerland's borders using the latest available official indicators.

1.3 Structure of the publication

This publication is organised as follows:

Chapter 2 focuses on the results of the last three R&D surveys conducted in private companies. These results will be used to highlight the level of R&D internationalisation in Switzerland. **Chapter 3** focuses on the results of R&D surveys carried out in the Confederation. This information will make it possible to put the Confederation's R&D activities in an international context. **Chapter 4** concludes this analysis by highlighting the key facts.

This publication provides a clear presentation of the various international dimensions of R&D and is aimed at students and journalists, as well as at researchers and policymakers interested in the subject.

[2] Cf. Federal Statistical Office – economiesuisse (2010), "La recherche et le développement dans l'économie privée en Suisse 2008", Joint FSO – economiesuisse publication, Zurich; and Federal Statistical Office (2010), "Dépenses et personnel de R-D des entreprises privées en Suisse 2008; augmentation des dépenses de R-D dans un contexte d'internationalisation croissante", FSO News, Neuchâtel.

2 Internationalisation of R&D in private enterprises

2.1 Reasons for internationalisation of R&D

The data collected through FSO surveys does not provide information on the reasons why enterprises internationalise their R&D activities. The main purpose of these surveys is to collect quantitative information on the amount of R&D expenditure, its funding and the profile of the researchers involved. There is, however, a large body of literature on this subject as well as various studies conducted specifically on it, particularly by organisations such as the Organisation for Economic Cooperation and Development (OECD). But it is important to give a brief overview in this chapter of the main reasons enterprises have for doing this, in order to ensure a better interpretation of the results presented in this study.

R&D is one the most strategically critical activities enterprises carry out. On the one hand, this is because it forms the basis of the company's activities involving technological innovation and therefore plays a crucial factor in its competitiveness and growth. On the other hand, it contains a high level of knowledge content, entailing a risk that the enterprise's knowledge might be disclosed to its competitors.

There are numerous reasons why enterprises may be motivated to carry out R&D activities abroad, but they can be briefly grouped into **two broad categories**: (i) reasons based on the desire to exploit the company's existing stock of knowledge (exploitation research activities) and (ii) reasons based on the desire to increase the amount of knowledge (exploration research activities).

When an enterprise wants to set up a subsidiary abroad to conduct **exploitation research** activities, its main reason is generally to adapt its products or processes to foreign conditions. The research should enable the enterprise to improve its products or processes based on specific local market conditions. These new products take into account consumer tastes and needs, the population's education level, and the technical standards and regulations of the country. As a result, research facilitates the development of sales and the opening of new markets abroad.

Another important reason worth noting is the use of a skilled workforce available abroad, which the enterprise cannot always find in its own country. In this case, enterprises seek to establish themselves in countries where a skilled workforce is available in significant numbers.

When an enterprise wants to establish itself abroad to conduct **exploration research** activities, its main reason is to gain access to knowledge generated by foreign innovation systems. In fact, enterprises do not always find all the technologies or knowledge they need in their own country because certain types of knowledge can only be developed through personal interactions and the enterprise's external network.

Empirical studies[3] have made it possible to identify the main reasons for Swiss and foreign multinationals getting involved in research activities abroad. The search for new markets and a skilled workforce is the reason most often cited. However, since the 1990s, it appears that R&D abroad has taken on a more strategically significant role. Research is no longer aimed exclusively at supporting production activities. It is increasingly used for the purposes of exploration. Consequently, enterprises' internationalisation strategies are attributable, to a large extent, to the high level of R&D activities carried out externally.

By carrying out their R&D activities abroad, Swiss enterprises certainly run the risk of spreading some of their knowledge abroad, but it mainly enables them to gain access to local information from their foreign competitors which would otherwise be inaccessible to them remotely.

[3] See, for example: Arvanitis, S. and Hollenstein, H. (2010), "How do different motives for R&D investment in foreign locations affect domestic firm performance? An analysis based on Swiss panel micro data", KOF Working paper, No. 258, May 2010. Also: Michel, J. (2009), "Investissements directs à l'étranger dans les activités de recherche et développement: fondements théoriques et application aux entreprises suisses", Peter Lang, European University Publications, Berne.

It is also clear from studies by the OECD that the location of centres dedicated to exploitation research is strongly influenced by the proximity of the markets targeted by the multinationals. On the other hand, for centres dedicated to exploration research, the location is mainly influenced by framework conditions such as the availability of a skilled workforce and the quality of infrastructure.

2.2 Purpose of the study

2.2.1 Differentiation between independent enterprises and group affiliates

One requirement when carrying out an in-depth analysis of R&D internationalisation is to be able to differentiate between enterprises according to their legal status (see Box 1). The data collected in Switzerland in 2008 allows this distinction to be made for the first time. It therefore makes it possible to differentiate between Swiss independent enterprises and enterprises belonging to a group. Within this latter category affiliates under foreign control can also be identified. Lastly, it is possible to identify among the Swiss groups those with foreign affiliates actively involved in R&D and to analyse them separately.

Box 1: Types of enterprises

Swiss independent enterprise
An enterprise is an institutional unit which exercises control over one of more establishments.
An enterprise is independent if it is not part of an enterprise group, i.e. it does not control any other enterprise and if it is not controlled itself by another enterprise.

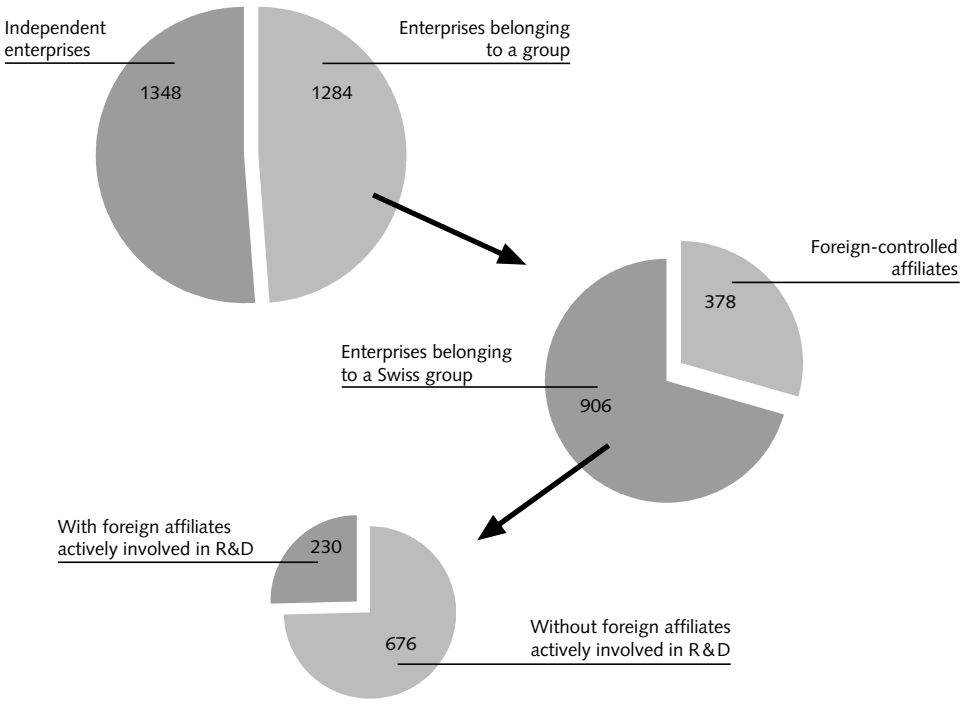
Swiss foreign affiliate
This is an enterprise located abroad which is directly or indirectly controlled by a parent company located in Switzerland.

Foreign-controlled affiliate
This is an enterprise located in Switzerland, which is controlled by a parent company located abroad.

Consequently, 2,632 enterprises actively involved in R&D in Switzerland were registered in 2008, nearly half of which (1,284) belonged to groups (Swiss or foreign). Within this category of enterprises 378 were foreign-controlled affiliates (see graph G1).

Taking into account the type of enterprise therefore makes it possible to portray the situation in Switzerland in relation to the internationalisation of R&D by enterprises.

Enterprises actively involved in R&D in Switzerland according to type of enterprise, 2008 **G 1**



Source: FSO

2.2.2 Different ways of measuring R&D internationalisation according to the enterprises' degree of involvement

In order to be able to present the different ways of measuring internationalisation in a structured manner, they are classified according to the degree of involvement the enterprises have in the knowledge transfer process. In this case, **three levels** of involvement are identified:

Level one is where enterprises have the highest degree of involvement in the internationalisation process. This is where there is a **group subsidiary** carrying out R&D outside the country where the parent company is located. One feature of this form of internationalisation is the need for **considerable long-term investments** from a multinational in a foreign market. Two measurements can be used to see where this process is going on. The first indicator is the measurement of R&D intramural expenditure for Swiss foreign affiliates. This measurement can be used to evaluate the expansion of Swiss multinationals in terms of R&D on foreign markets. The second indicator relates to the R&D expenditure of affiliates under foreign control carried out in Switzerland. This measurement can be used to see the proportion of R&D carried out by these affiliates in Switzerland.

The **second level** of involvement includes measurements for **R&D extramural expenditure** where the service provider is located outside the relevant country. This involves, on the one hand, measuring R&D contracts carried out in Switzerland for a foreign customer (sale abroad) and, on the other hand, Swiss R&D contracts assigned to a foreign service provider (purchase from abroad).

This second group of measurements indicates a **less sustained level of involvement** than the first group. Although there is indeed cooperation between the customer (who awards the contract) and the contractor (who carries out the contract), this method of cooperation requires a significantly lower level of investment than having an affiliate established abroad. In addition, the exchange of knowledge through the contract is generally only carried out on a **short- or medium-term basis**.

Finally, the **third level** of involvement, which is the least restrictive, involving only short-term knowledge transfer, relates to **the purchase and sale of patents**, licences and disembodied technologies abroad. These R&D exports and imports feature in the technology balance of payments.

2.3 R&D carried out abroad by multinationals' subsidiaries

2.3.1 R&D intramural expenditure for Swiss foreign affiliates

Intramural R&D expenditure of foreign affiliates is the most widely used indicator for measuring the level of R&D internationalisation and technology transfer. This expenditure can be defined as the expenses covering all the R&D activities carried out by the affiliates of multinational enterprises established abroad.

According to the last survey, 230 enterprises actively involved in R&D have foreign affiliates which also invest in research. This is 21% of the groups actively involved in R&D in Switzerland.

In 2008 R&D intramural expenditure for Swiss subsidiaries abroad rose to **CHF 15.8 billion**, marking a 64% rise compared to 2004, the last year the survey was carried out before 2008. Since 1992 there has been a rapid increase in these affiliates' expenditure, apart from in 1989 and 2004, to the extent that they allocate more resources to R&D than all the enterprises in Switzerland.

To provide a better comparison of the scale of R&D internationalisation in different countries, the amount of R&D intramural expenditure for the Swiss foreign affiliates is expressed in relation to the business enterprise expenditure on R&D (BERD).

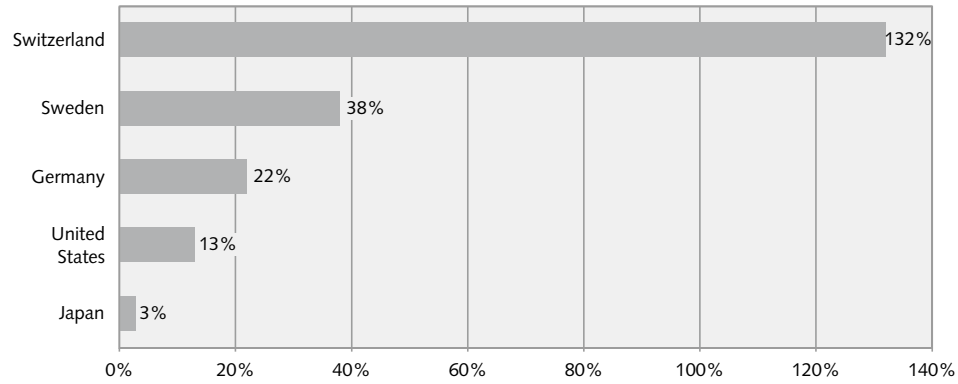
T 1 Business enterprise intramural expenditure on R&D and R&D intramural expenditure of Swiss foreign affiliates, 1989–2008

In CHF millions, current prices

	1989	1992	1996	2000	2004	2008
Business enterprises in Switzerland	6 210	6 370	7 060	7 890	9 659	11 979
Swiss foreign affiliates	5 270	7 090	8 060	9 788	9 603	15 769
Ratio of R&D intramural expenditure of swiss foreign affiliates versus business enterprises' R&D intramural expenditure	**85%**	**111%**	**114%**	**124%**	**99%**	**132%**

Source: FSO

R&D intramural expenditure for national foreign affiliates, international comparison, 2008[1] **G 2**



[1] Exception to the reference year 2008: Germany, United States, Japan, Sweden: 2007

Source: OECD, "globalisation" – Statistical database

In 2008 the R&D intramural expenditure for Swiss foreign affiliates was 132% of the BERD. The rise in this rate since 1989 indicates the rapid expansion of R&D in Swiss enterprises at international level.

In most other OECD countries, this ratio lies between 2% and 30% of the total R&D intramural expenditure. A rate of 132% in 2008 indicates that R&D in the private sector in Switzerland is one of the most internationalised in the world.

This high rate can be explained by the specific nature of the research environment in Switzerland, which **focuses very much** on R&D carried out by enterprises in the "Pharmacy" industry.[4] In 2008 this branch of activity allocated CHF 4.6 billion to intramural expenditure on R&D carried out in Switzerland, representing 39% of the total expenditure on R&D in Switzerland. During the same period, the foreign subsidiaries of these same enterprises spent CHF 10.6 billion on intramural R&D, which is two thirds of the total R&D expenditure for Swiss foreign affiliates.

Consequently, the level of commitment outside Switzerland of Swiss enterprises operating in the Pharmacy branch means that they achieve top marks for their R&D internationalisation ratio, based on international comparison.

This sector's desire to internationalise its R&D activities has been evident for several years. In 2004 the sector was already allocating 68% of its expenditure to R&D abroad.

Box 2: R&D industries

In the Business and Enterprise Register (BER), enterprises are classified according to their main activity in various economic sectors, arranged according to the "General Classification of Economic Activities" (NOGA). As part of the 2008 R&D survey, the NOGA 2002 sectors were grouped, for analysis purposes, to form the 10 R&D industries listed below.

- Food
- Chemistry
- Pharmacy
- Metallurgy
- Machinery
- High-technology instruments
- ICT manufacturing
- ICT services
- Research and Development
- Others

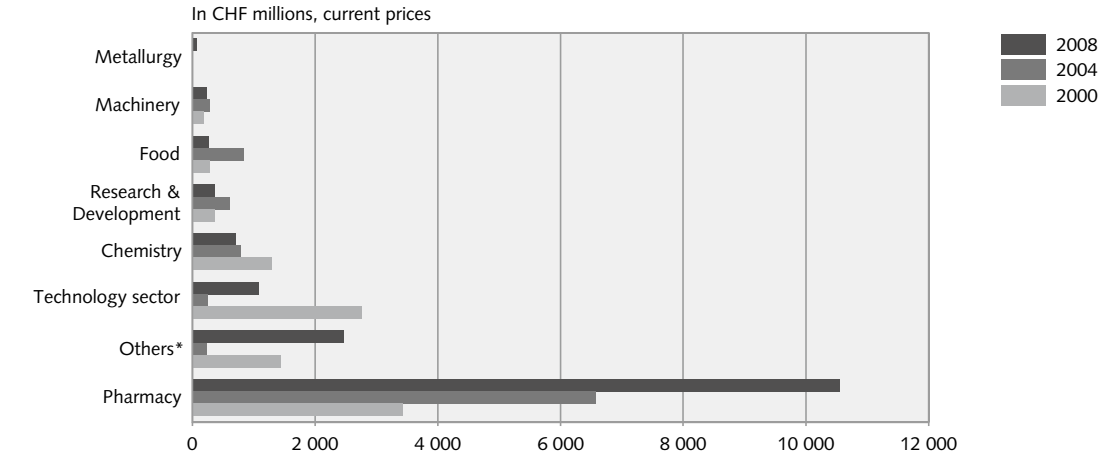
The technology sector is made up of 3 industries with a significant technological content: high-technology instruments, ICT manufacturing and ICT services.

Beyond the Pharmacy industry

The **Technology sector**, which includes ICT manufacturing, ICT services and high-technology instruments, is the second main player in the expansion of Swiss R&D abroad, with R&D expenditure for their foreign affiliates amounting to **CHF 1.1 billion**. This amounts to 7% of R&D expenditure abroad. However, although this figure is fairly modest compared to that for the Pharmacy industry, this sector is rapidly becoming more internationalised. Indeed, the expenditure of the foreign affiliates in this branch increased fourfold between 2004 and 2008.

[4] Federal Statistical Office – economiesuisse (2010), "La recherche et le développement dans l'économie privée en Suisse 2008", Joint FSO – economiesuisse publication, Zurich.

R&D intramural expenditure of Swiss foreign affiliates by industry, 2000–2008 **G 3**



* 2000 and 2004: with Insurance sector, 2008 without Insurance sector

Source: FSO

Lastly, the other sectors, apart from metallurgy, are tending to reduce their R&D expenditure abroad (see graph G3).

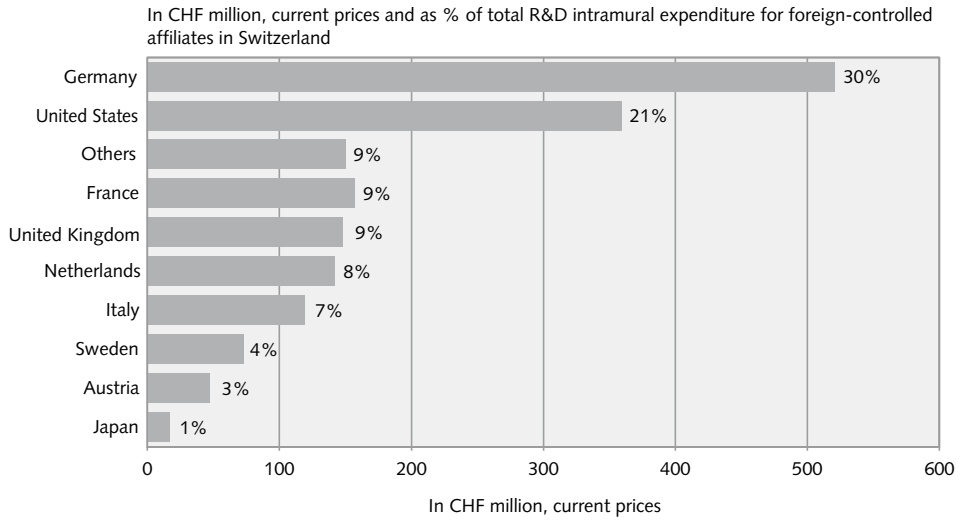
2.3.2 R&D expenditure of foreign-controlled affiliates in Switzerland

Just as Swiss multinationals have sforeign affiliates, the same applies to foreign multinationals which set up affiliates in Switzerland. Consequently, in 2008, 378 enterprises actively involved in R&D in Switzerland were affiliates under foreign control. These enterprises account for 14% of the enterprises actively involved in R&D in Switzerland (also accounting for 14% of the R&D intramural expenditure in Switzerland, amounting to CHF 1.7 billion).

These foreign-controlled affiliates originate from 23 different countries. However, just 4 countries control almost three quarters of these subsidiaries: Germany (33%), the United States (18%), France (14%) and the UK (7%).

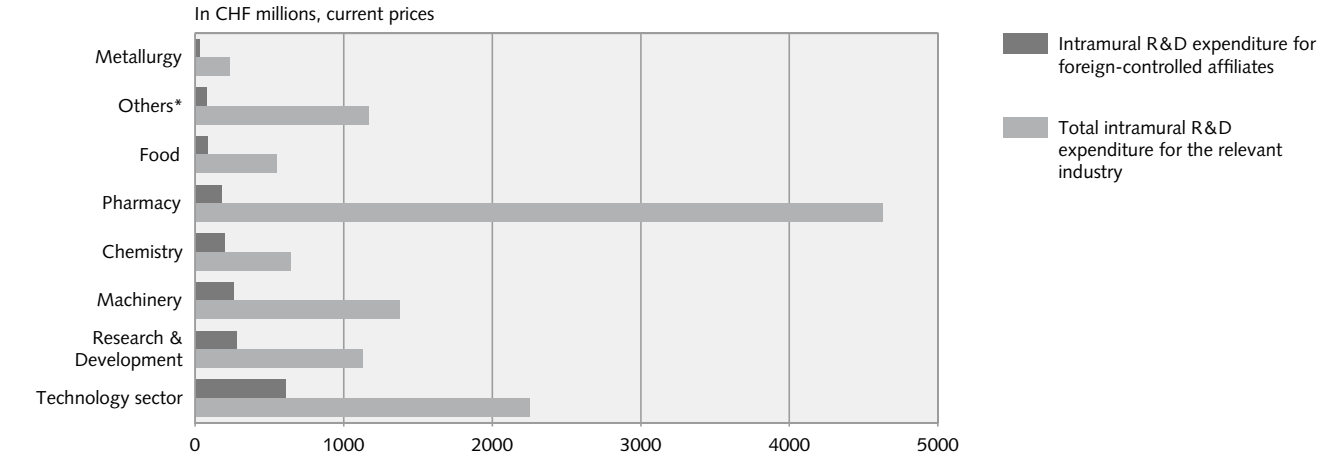
These same countries account for more than 68% of the R&D intramural expenditure for this kind of affiliates.

R&D intramural expenditure (in Switzerland) of foreign-controlled affiliates according to parent company's country of origin, 2008 **G 4**



Source: FSO

R&D intramural expenditure for foreign-controlled affiliates compared to the total for the business enterprise sector by industry, 2008 **G 5**



* 2000 and 2004: with Insurance sector, 2008 without Insurance sector

Source: FSO

Concentration of foreign-controlled affiliates in four sectors

A closer look at the expenditure of these enterprises according to their economic sector highlights that their R&D efforts are focused on a limited number of sectors. In fact, in relation to all the enterprises operating in Switzerland, foreign-controlled affiliates account for 31% of R&D expenditure in the Chemistry sector, 27% in the Technology sector, 24% in Research and Development and 19% in the Machinery sector. These respective shares are high, especially as it was previously mentioned that these affiliates accounted for 14% of R&D intramural expenditure in Switzerland. The necessary conclusion from this is that foreign-controlled affiliates located in Switzerland focus mainly on these economic sectors.

Foreign-controlled affiliates are more inclined towards experimental development

Box 3: Types of R&D

R&D activities comprise three types of R&D:

- **Basic research** is experimental or theoretical work undertaken to acquire new knowledge without any particular application or use in mind.
- **Applied research** is work which involves considering the available knowledge and its extension in order to solve particular problems and achieve predetermined objectives.
- **Experimental development** is work based on existing knowledge aimed at producing something new.

In 2008 foreign-controlled affiliates carried out mostly experimental development. 60% of their R&D expenditure is earmarked for this kind of research. As a comparison, the other Swiss enterprises allocated nearly 54% of expenditure to this. Regarding basic research expenditure, foreign-controlled affiliates devoted only 5% of their expenditure to this, compared to 9% for the other enterprises in Switzerland.

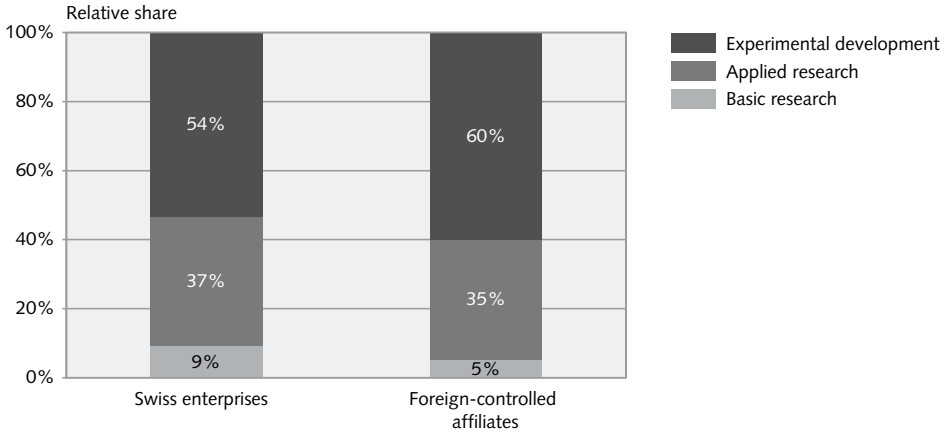
The proportion of expenditure devoted to R&D by foreign-controlled affiliates in Switzerland is relatively limited in international comparison

Based on international comparison, the proportion of expenditure devoted by this type of affiliates to R&D in Switzerland (14%) is relatively low. Some countries, like Ireland and Austria, depend much more than Switzerland does on R&D carried out by these affiliates to boost their domestic R&D effort. The figure of 14% puts Switzerland almost on a par with the United States.

Switzerland's position might give the impression that it is not an attractive location for foreign enterprises wishing to carry out R&D activities. However, some caution is advised when interpreting this result. In fact, just like the United States, Switzerland has "local" enterprises which are very actively involved in R&D. Consequently, the amount of R&D expenditure in the private sector there is very high. As a matter of interest, the level of R&D expenditure of enterprises in Switzerland is among the highest in the world.[5]

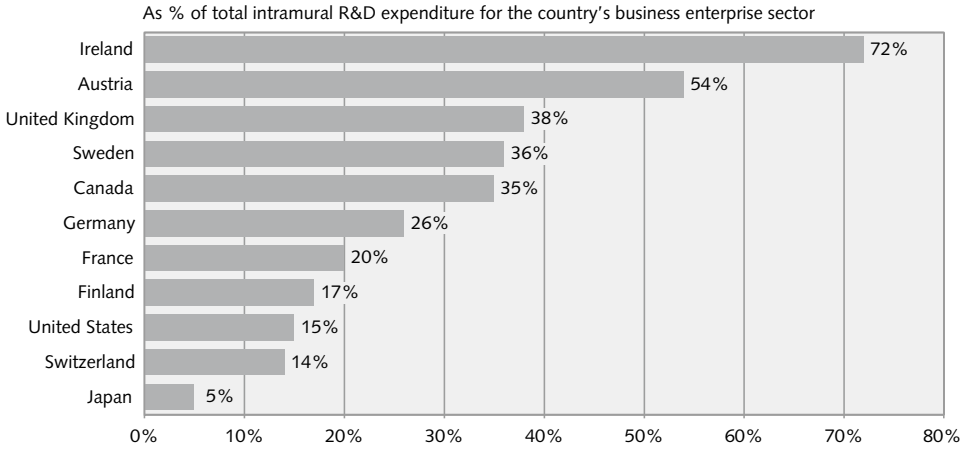
[5] Federal Statistical Office (2010), "Dépenses et personnel de R-D des entreprises privées en Suisse 2008; augmentation des dépenses de R-D dans un contexte d'internationalisation croissante", FSO News, Neuchâtel.

R&D intramural expenditure by type of R&D and enterprise, 2008 **G 6**



Source: FSO

R&D intramural expenditure for foreign-controlled affiliates, international comparison, 2008[1] **G 7**



1 Exception to the reference year 2008: Finland:2006, Austria, Canada, France, Germany, Ireland, Japan, Sweden, United Kingdom, United States: 2007

Source: OECD, "globalisation" – Statistical database

As a result of this very intense level of R&D, the proportion of R&D carried out by foreign affiliates in Switzerland is relatively limited. This situation has already been observed and similarly explained for the United States.[6]

This very intense level of R&D in Switzerland can be mainly attributed to the strong R&D activities of the major groups in the Pharmacy industry. Apart from this sector, it has been noted that foreign-controlled affiliates are definitely more active in the Technology sector, as well as in the Research and Development, Chemistry and Machinery industry. It would therefore seem that the attractiveness of Switzerland for these industries must not be underestimated.

6 Harfi, M. and Mathieu, C. (2008), "Internationalisation de la R&D des entreprises et attractivité de la France", Horizons stratégiques, 2008/1 No. 7, p. 72-92.

2.3.3 R&D intramural expenditure of Swiss foreign affiliates far higher than that for foreign-controlled affiliates

It was possible for the first time in 2008 to compare the amounts of intramural expenditure for Swiss foreign affiliates with those for foreign-controlled affiliates located in Switzerland.

The difference is striking. In 2008 the expenditure of Swiss foreign affiliates increased to CHF 15.8 billion, while, for the same year, the expenditure of the foreign-controlled affiliates (in Switzerland) rose to CHF 1.7 billion.

Compared to the BERD (which reached CHF 12 billion in 2008), the amount for the expenditure of foreign-controlled affiliates is limited.

By contrast, the Swiss foreign affiliates allocated considerable sums to R&D expenditure. Given that this expenditure saw an average annual increase of 6% between 2000 and 2008, while, during the same period, the R&D intramural expenses of enterprises located in Switzerland rose by 5%, it can be confirmed that the growth in R&D expenditure of the foreign affiliates is not part of an R&D relocation process. On the contrary, the expansion of foreign affiliates would be likely to play a complementary role, allowing multinationals to increase their R&D efforts which the Swiss market could not satisfy alone.

2.4 R&D contracts awarded or received from abroad

The second level of involvement of enterprises in the international exchange of R&D involves R&D contracts[7] which are either paid for or carried out abroad. The feature of these contracts is that cooperation between the customer and contractor takes place during a limited period of time and the investment needed to acquire the results of the R&D is smaller compared to that required for establishing a subsidiary abroad.

The two measurements presented in this section relate, on the one hand, to R&D carried out in Switzerland, but financed by a foreign institution via a contract and, on the other hand, to R&D acquired by the enterprises based in Switzerland against payment as part of a contract carried out by an institution abroad.

2.4.1 R&D carried out in Switzerland based on contracts from abroad

In 2008 only 15% of the enterprises analysed received R&D contracts from abroad. These 407 enterprises included 104 foreign-controlled affiliates (26%), 115 enterprises belonging to Swiss groups (28%) and 188 independent enterprises (46%). However, taking into account the sums paid based on the contracts (cf. Table 2), it is noticeable that foreign-controlled affiliates were the main beneficiaries of this type of financing. In fact, this provided funding of up to CHF 409 million for their R&D activities. As for the independent enterprises, they only received CHF 298 million via this channel and, lastly, the enterprises belonging to a Swiss group benefited least from this method, with an amount of CHF 137 million.

Consequently, although these affiliates (in terms of number of enterprises) are not the biggest group benefiting from foreign funding, in actual monetary terms, they receive the most financial resources for R&D activities carried out in Switzerland. This result is mainly explained by the legal nature of these enterprises. In fact, as they are part of a group of foreign enterprises, it is completely natural for them to be more inclined towards an international customer base (including the group's affiliates) than the Swiss independent enterprises.

Overall, the sums received through contracts only finance a small part of the R&D expenditure of the enterprises located in Switzerland. In 2008, the funding received in this form rose to CHF 1.6 billion. Half of this (CHF 844 million) came from contracts awarded by organisations abroad, accounting for slightly more than 7% of the total amount of R&D activities in Switzerland.

However, the amount from contracts from abroad increased significantly in absolute terms, rising from CHF 460 million in 2000 to CHF 844 million in 2008. At first glance, this rise of 84% is considerable. If the growth of the entire R&D intramural expenditure of enterprises over the same period is taken into account, it can be noted that the share of funding provided by contracts from abroad rose from 6% in 2000 to 7% in 2008.

The Research and Development sector receives most of the contracts coming from abroad

The contracts received from abroad focus on a few industries. More than half (58%) of the contracts from abroad are received by enterprises in the Research and Development industry. Almost a quarter are awarded to the Technology sector (22%). By contrast, the Pharmacy industry, which accounts for 39% of the total amount of R&D intramural expenditure in Switzerland, receives only 2% of the contracts and contributions from abroad.

These foreign funds provide the Research and Development industry with an important lifeline as they fund 44% of the R&D intramural expenditure of the enterprises in this branch.

Since 2000 there has been a steady rise in the R&D financed from abroad in the Technology sector and Research and Development industry, whereas it has declined for all the other sectors over the same period.

[7] Over the entire period of the analysis, it is not possible to differentiate systematically between the contracts and contributions from enterprises. Unlike a contract, a contribution does not give the entity financing the R&D activity the right to look at or own the research. In this document, to simplify the reading of the text, the generic term "contract" is therefore used to mean both contracts and contributions. However, this should not cause any problem as contributions only account for a minimal share of the entire financing involved.

T 2 Source of funds for R&D intramural expenditure, by type of enterprise, 2008
In CHF millions, current prices

	Funding from abroad	Funding from Switzerland	Total	Relative share of R&D intramural expenditure from abroad
Independent enterprises	298	1 105	1 403	21%
Enterprises belonging to a Swiss group	137	8 708	8 845	2%
Foreign-controlled affiliates	409	1 322	1 731	24%
Total	**844**	**11 135**	**11 979**	**7%**

Source: FSO

Swiss enterprises only carry out a few contracts for companies abroad

Based on international comparison, the proportion of R&D intramural expenditure in Switzerland financed from abroad is relatively small. In fact, 7% of R&D intramural expenses are financed via this method, which puts Switzerland below the European (EU-27) average of 11%.

This result may seem surprising, given that it is usual to see Switzerland featuring among the leading pack in the field of R&D when it comes to international comparisons. However, caution is advised when interpreting this result in the appropriate manner. Swiss enterprises do fund a low percentage of their R&D expenditure via foreign contracts. But this does not mean that the absolute amounts provided by these contracts are small. This low percentage can be attributed to the fact that the amount of R&D expenditure which enterprises allocate to themselves is very high. In other words, Swiss enterprises devote a great deal of resources to their own R&D activities, as a result of which the amount of R&D expenditure allocated to contracts from abroad is comparatively small.

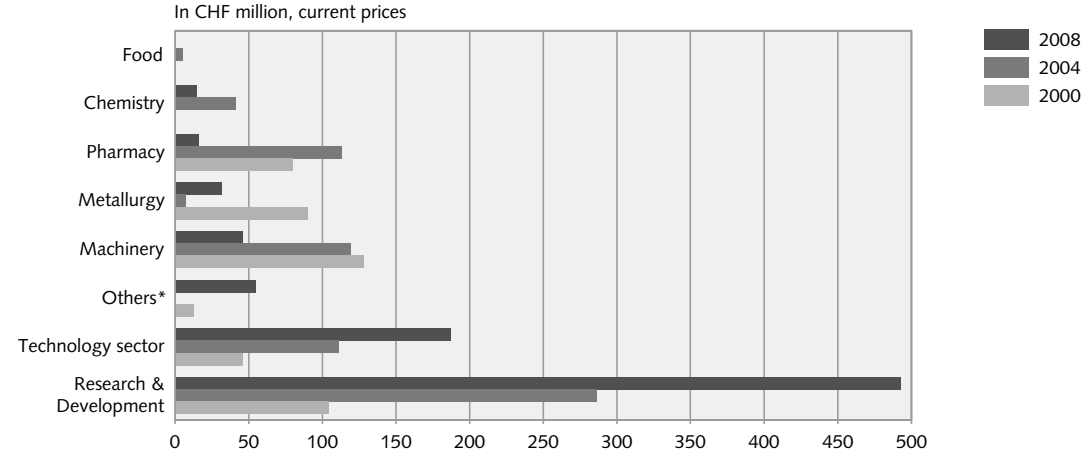
2.4.2 Financing from Swiss enterprises for R&D carried out abroad (R&D contracts abroad)

In 2008 16% of enterprises actively involved in R&D financed research abroad through contracts or contributions. Among these 410 enterprises with R&D extramural expenditure abroad, 19% were foreign-controlled affiliates, 52% Swiss multinationals and 29% independent enterprises.

In 2008 Swiss enterprises acquired more than CHF 2 billion of research through contracts carried out by a foreign organisation.

The total amount of R&D extramural expenditure for enterprises in Switzerland rose to CHF 3.2 billion in 2008. CHF 2.2 billion of this amount (69%) was paid to foreign service providers carrying out contracts awarded by Swiss enterprises.

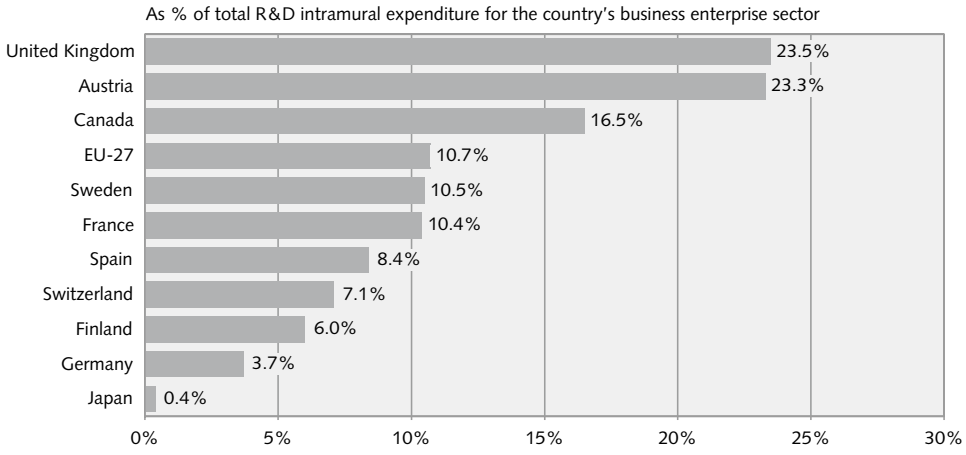
R&D intramural expenditure funded from abroad by industry, 2000–2008 **G 8**



* 2000 and 2004: with Insurance sector, 2008 without Insurance sector

Source: FSO

R&D intramural expenditure for the business enterprise sector, funded from abroad, international comparison, 2008[1] **G 9**



[1] Exception to the reference year 2008: Austria, EU-27, Germany, Spain, Sweden: 2007

Source: OECD, MSTI database, STI/EAS Division, Paris, January 2011 *© Federal Statistical Office (FSO)*

Box 4: R&D extramural expenditure
Extramural expenditure is the sums which enterprises or other organisations pay other organisations for performing R&D which they assign to be carried out externally. This includes acquisition of R&D performed by other units (R&D contracts) and grants (R&D contributions) given to others for performing R&D.
The acquisition of know-how through purchasing patents or licences is considered as R&D performed outside the enterprise and comes under R&D extramural expenditure.

Between 2004 and 2008 R&D extramural expenditure allocated abroad fell (-8%). This drop can be explained in particular by the exceptionally high extramural expenditure in 2004. If a comparison is made of the years 2000 and 2008 only, extramural expenditure abroad almost doubled in 8 years.

It can be noted over the same period that Swiss enterprises turned increasingly to foreign service providers to carry out their R&D contracts. In fact, whereas in 2000 64% of extramural expenditure was paid to providers abroad, this share rose to 69% in 2008.

The Pharmacy industry and Research and Development industry award the most contracts

The Pharmacy industry and Research and Development industry are those which spend the most on R&D contracts abroad.

In 2008 the Pharmacy industry accounted for 42% of the total R&D extramural expenditure abroad, having awarded contracts worth CHF 944 million abroad. In second place, the Technology sector allocated CHF 560 million, equivalent to 25% of the total. In third place came the Research and Development industry with a total of CHF 163 million, equivalent to 7%.

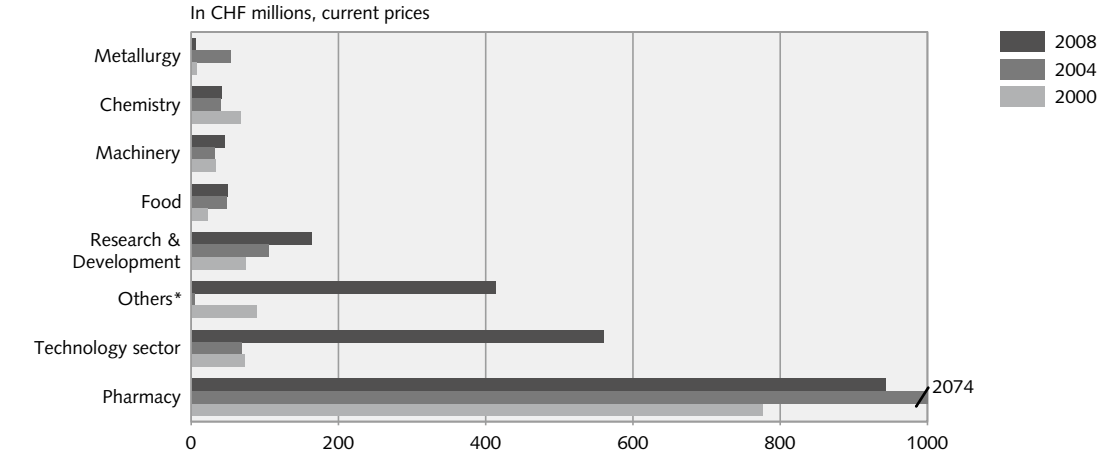
While the Pharmacy industry saw a drop in its expenditure on contracts between 2004 and 2008 (-54% following an exceptional 2004 and a return to normal in 2008), the Technology sector and Research and Development branch, by contrast, are increasingly active in awarding contracts abroad. The Technology sector, which only made a minimal contribution to extramural expenditure abroad in 2004 (3%), is now responsible for 25% of this kind of expenditure. The Research and Development industry's share has increased from 4% to 7%.

In conclusion, it is noticeable that Swiss enterprises are major consumers of R&D. In fact, although Swiss enterprises are responsible for a huge amount of R&D intramural expenditure, it is primarily for their own requirements. Out of the CHF 12 billion spent in 2008,[8] "only" CHF 844 million was for research contracts intended for organisations abroad. At the same time, Swiss enterprises paid CHF 2.2 billion for R&D based on contracts awarded to foreign service providers.

These results suggest that Swiss enterprises have such a high demand for R&D that domestic production, although among the highest in the world, cannot meet all their requirements. Consequently, enterprises acquire R&D on the international market through contracts awarded to providers located outside Switzerland.

[8] Op. cit. note at bottom of page 4.

R&D extramural expenditure abroad by industry, 2000–2008 **G 10**



*2000 and 2004: with Insurance sector, 2008 without Insurance sector

Source: FSO

2.5 Import and export of R&D and disembodied technologies

Box 5: Technology Balance of Payments (TBP)
The technology balance of payments (TBP) measures the commercial transactions relating to international transfers of technology. It records the financial amount paid or received for acquiring or using patents (purchases, sales), licences for patents, know-how (not patented), models and designs, trademarks, technical services and financing industrial R&D outside the national territory.
Source: OECD, Main Science and Technology Indicators, volume 2010/1, p. 111

The last level of R&D exchange involves importing and exporting R&D, along with disembodied technologies.[9] This method of exchanging R&D requires the least involvement by enterprises as it simply entails purchasing a licence or patent from a specialist market.[10]

The analysis of R&D internationalisation, from the perspective of the technology balance of payments (TBP), relates to the financial sums paid or received for acquiring or using disembodied technology.

According to the OECD definition, the TBP should cover the financing of R&D outside the relevant country, i.e. R&D extramural expenditure.

However, in Switzerland and most of the countries which provide TBP data, this expenditure is not included in the results. Consequently, the figures mentioned below do not take into account the extramural expenditure mentioned earlier.

These transfers give an indication of a country's ability to sell its technology abroad and to use foreign technologies. They reflect this country's competitive position on the global market for technological knowledge.

Over the entire period illustrated in Table T3, extremely rapid growth can be seen in terms of TBP income and expenditure (i.e. exports and imports of R&D respectively). In fact, between 1995 and 2008 R&D exports increased more than fourfold, while imports rose more than seven times.

These remarkable figures clearly highlight the sharp rise in exchanges of R&D between the Swiss economic sector and countries abroad.

A clear acceleration in TBP income and expenditure has been noted since 2000. The pattern of these developments is reminiscent of a very similar development with regard to the amount of intramural expenditure of Swiss enterprises during the same period. As in the case of this expenditure, after showing relatively steady growth during the 1990s, a definite acceleration is observed in TBP expenditure between 2000 and 2008. During this period, Swiss R&D exports increased almost fourfold, while imports more than doubled. Consequently, in 2008, with exports rising to USD 12.7 billion and imports to USD 11.9 billion, international trade in R&D reached levels comparable to the entire amount of intramural R&D expenditure for Swiss enterprises. This underlines once again the importance of this kind of transaction to the technological environment in Switzerland.

[9] To make it simpler when reading this document, the expression "Import/export of R&D and disembodied technologies" will be simplified to "Import/export of R&D".

[10] The TBP figures do not only relate to private enterprises, but to all the actors in the Swiss economy. However, given that the TBP measures commercial transactions, the latter are mainly carried out by private enterprises, which is why this indicator appears in this chapter.

T 3 Swiss technology balance of payments, 1995–2008
In USD millions, current prices

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Receipts	2 788	2 722	2 876	3 780	2 880	3 407	5 594	4 668	5 072	7 584	9 799	9 089	10 317	12 730
Payments	1 602	1 540	1 284	1 672	2 331	5 337	3 958	5 479	5 866	9 110	10 900	12 538	14 669	11 873
Balance = Receipts-payments	**1 186**	**1 181**	**1 592**	**2 108**	**548**	**–1 930**	**1 636**	**–810**	**–794**	**–1 527**	**–1 101**	**–3 449**	**–4 352**	**857**

Source: OECD, MSTI database, STI/EAS Division, Paris, January 2011; FSO calculations

These results indicate that Swiss enterprises are competitive on the international markets for R&D and technology. The highly sustained growth in exports in these recent years highlights how important the international R&D market is to Swiss enterprises and their competitiveness.

At the same time, the very large rise in imports indicates not only that Swiss enterprises have an increased demand for R&D, but also that they are able to assimilate rapidly the latest technological developments acquired in this way.

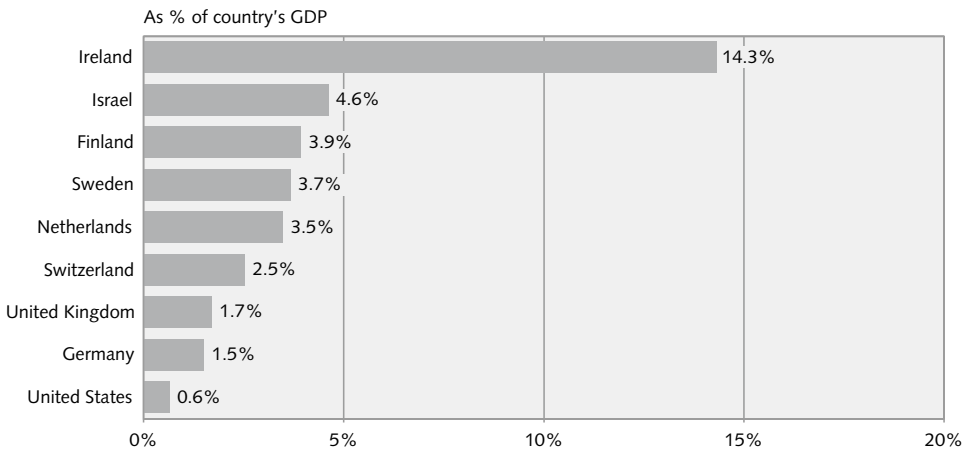
International comparison of R&D and technology exports from Switzerland

To provide a better understanding of the importance of R&D exports and Switzerland's competitive situation, an international comparison can be made (graph G11). In order to compare the R&D exports of the various countries, they are expressed as a percentage of the gross domestic product (GDP) of the relevant countries.[11]

In 2008 Switzerland's exports amounted to 2.5% of its GDP, which put it in a good position in the rankings of OECD countries exporting R&D and disembodied technologies.

Due to the relatively limited size of its domestic market, Switzerland, just like Belgium and the Netherlands, is strongly geared towards external markets. On the other hand, Germany and the United States, two countries whose level of R&D activity is also very high, are less open to the international trade in R&D. This situation can be explained in particular by the size of their domestic markets. As they are huge, domestic demand consumes a larger share of production, whereas smaller economies (like Switzerland's) are likely to be more open to foreign markets.

Technology balance of payments: income, international comparison, 2008 **G 11**



Source: OECD, MSTI database, STI/EAS Division, Paris, January 2011

[11] As explained earlier, as the TBP refers to all economic sectors (and not only private enterprises), the ratio is calculated based on the R&D expenditure for all the sectors combined in the relevant country.

2.6 Conclusion: enterprises hungry for R&D

In the light of all these indicators, the private enterprise sector in Switzerland is undeniably a major player in the internationalisation of R&D.

The traditional measurements of internationalisation indicate that the foreign subsidiaries of Swiss enterprises devote considerable sums to R&D activities, making Switzerland a totally exceptional case with such a high level of internationalisation. Although the R&D expenditure of Swiss subsidiaries abroad is rising steadily, this growth is not detrimental to the progression of the R&D effort inside Switzerland. It would therefore be wrong to talk about the relocation of R&D. It would be more appropriate to talk about a steady expansion of the R&D activities of multinationals, facilitated by access to foreign markets.

If consideration is then given to "alternative" indicators such as contracts and TBP data, it seems that Swiss private enterprises are not only competitive on international markets, but they also consume huge amounts of R&D. In fact, it is noticeable that the entire Swiss economy resorts to international markets to meet its increasing demand.

This signals that the entire Swiss economy is strongly geared towards high value-added production, which, itself, requires advanced technology.[12]

[12] This fact serves to corroborate the observations already made in a previous FSO publication, which stated that Swiss production focused on the industries offering high value added and a high technological content. For more information, refer to the Federal Statistical Office (2008): "Analyse structurelle de l'économie suisse: Evolution du secteur manufacturier de 1991 à 2005 – Vers une concentration sur les branches à forte valeur ajoutée", FSO News, Neuchâtel.

3 International cooperation in the R&D sector

3.1 State encourages international research

While enterprises use international exchanges to develop their R&D activities and increase their knowledge base, States use the same method for acquiring the latest scientific and technological developments. As a result, the Swiss Confederation favours the exchange of knowledge with the rest of the world as part of international research cooperation programmes, in order to promote its scientific sector and guarantee the competitiveness of its research.

However, it must be pointed out that the incentives the state has for participating in this type of programme are very different to those of enterprises which internationalise their research. Given that an enterprise's main aim is to make a profit, internationalisation strategies offer a means of acquiring new knowledge in the most efficient manner possible with the aim of obtaining a competitive edge through a technological development. On the other hand, a state's aim is to promote its scientific sector as a whole by encouraging research and freely distributing new knowledge across the country with the aim of enhancing the performance and competitiveness of the actors in its economy through the acquisition and assimilation of new knowledge.

For this reason, cooperation programmes relate more specifically to basic research projects. This type of research generally has no direct commercial application but still provides the basis for all technological progress. As a result, states favour the development of new knowledge, but find it easier to leave the areas of applied research and experimental development to enterprises, as these types of research have more specific commercial objectives.

International cooperation in the field of research is a means available to the Confederation to support and provide impetus to Switzerland's scientific sector, by encouraging researchers to collaborate on large-scale international projects. Developments could not be made in many areas without this cooperation due to their requirement for a huge infrastructure. A single country would find it very difficult to gather the resources required to carry out R&D activities in areas such as astronomy, aerospace or nuclear fusion. Nowadays, the creation of international cooperation programmes has led to a certain number of countries pooling their resources to carry out research activities in an efficient manner.

While new areas are being explored, interactions between researchers from the various countries involved in such projects are encouraging the emulation and acquisition of expertise, which is conducive to the good performance of the country's scientific sector, thereby fostering, in the long term, the framework conditions for lasting economic development.

International cooperation takes a number of different forms. The purpose of this chapter is to present all the commitments Switzerland has in terms of international research cooperation, focusing more specifically on the resources provided by the European Union's (EU) Research Framework Programmes (RFP).

3.2 What is international research?

International research includes all the research institutions (centres, programmes and projects) **managed or financed at international level** by several states.

When international research only involves cooperation between European countries (the 27 Member States of the EU, the EFTA member countries, including Switzerland, and the EU candidate countries), it is then called "European coordinated research".

The funding provided by states to European coordinated research is split into three categories:

- public contributions to major intergovernmental research institutions (e.g. CERN)[13]
- public contributions to various research programmes and instruments set up by the EU
- public contributions to common R&D projects financed by at least two European countries.[14]

[13] CERN is the European organisation for nuclear research based in Geneva.

[14] As part of this publication, it will involve a common project between Switzerland and at least one other European country.

Box 6: Examples of international research programmes and institutions
(The figure in brackets represents the contribution from Switzerland in 2008 in CHF millions)

CERN: European Organization for Nuclear Research (20)
CGIAR: Consultative Group on International Agricultural Research (7)
COST: Co-operation in Scientific and Technical Research, EU programme (7.5)
EMBL: European Molecular Biology Laboratory (4.8)
ESA: European Space Agency (156)
ESO: European Southern Observatory (6.8)
ESRF: European Synchrotron Radiation Facility (8.6)
FRP: European Union Research Programmes (240)

All the international cooperation involving the Swiss public sector (Confederation and cantons) can be illustrated in graph G12. In 2008 the state allocated 11% of its R&D expenditure to funding international activities (equivalent to a total of CHF 475 million).[15] Almost half of this amount was earmarked for funding European coordinated research (i.e. CHF 213 million).

The funding allocated to international research by the public sector is paid directly to the relevant projects or international institutions. However, as illustrated in graph G12, there is another form of international collaboration between European countries which is not accounted for in the CHF 475 million of funding provided by the Confederation and cantons. This is the European Union's Research Framework Programmes (RFP). RFPs have the following aims:

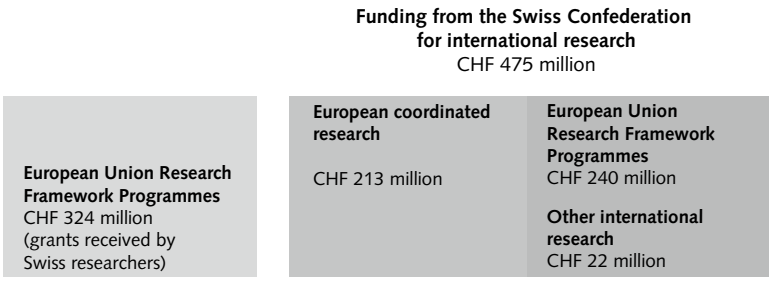
- To bring up to a high-quality level European research and technology in the key sectors.
- To inspire creativity and excellence in European research.
- To develop and strengthen human potential in European research.
- To improve research and innovation skills throughout Europe.

3.3 European Union Research Framework Programmes

RFPs are accounted for outside the budgets allotted to European coordinated research as these programmes are funded in a very specific way. In fact, only associated countries (including Switzerland) pay a special contribution for RFPs. This contribution is calculated based on their gross domestic product (GDP). EU Member States make a single contribution to the general European Union budget, which then funds directly the international research projects submitted by the researchers and their institutions.

At the moment, Switzerland is not guaranteed that it will be able to recover its entire contribution as grants are only given to projects submitted by researchers from the various Member States and accepted on a competition basis.

International research, 2008 **G 12**



Source: SER, FSO

[15] NB: The public sector's total R&D expenditure rose in 2008 to CHF 4.2 billion.

T 4 Government funding for international research, 2008
In CHF millions, current prices

	2008
European Coordinated Research	**213**
Including:	
Intergovernmental research institutions	40
European programmes for R&D	165
Research projects financed by at least two European countries	8
R&D contracts and contributions to other international research institutions and research programmes	**262**
Total for international research funding	**475**

Source: SER, FSO

Switzerland has been able to participate in RFPs since 1987, but it is only since 2004 that Switzerland has been able to participate as an "associated country". This status allows Swiss researchers to participate in RFPs on an equal footing with other European researchers.

Involvement in the European Union's Research Framework Programmes is one of the main priorities of science policy in Switzerland. The last twenty years has seen a steady rise in Switzerland's involvement: from third RFP (FP3) (1990–1994) to sixth RFP (FP6) (2003–2006), the number of Swiss researchers involved has increased from 500 to 1,916, while the amount of grants allocated has risen from CHF 127 million to roughly CHF 791 million.

3.3.1 Swiss researchers are competitive in the RFPs

As part of FP6, the European grants received by Swiss researchers amounted to 3.1% of the total grants awarded by the EU. At the same time, the proportion of funding contributed by Switzerland to FP6 rose to 2.7%. It is immediately evident that the grants received by Swiss scientists exceeded the country's contribution.

If you correlate the proportion of grants awarded to Swiss researchers with the share of the funding from Switzerland, this provides an indicator measuring Swiss researchers' competitiveness in terms of obtaining European funds in relation to the funds invested by Switzerland. This measurement is called the "financial return coefficient" and was 1.14 for Switzerland's participation in the whole of FP6, which means that it was more competitive than average. This ratio actually means that for each Swiss franc contributed by Switzerland to the RFP, Swiss researchers received CHF 1.14 in grants.[16]

In 2007, as part of launching FP7, Switzerland contributed 2.6% of the budget for FP7. Swiss researchers received 3.8% of the grants. This gives a financial return coefficient of 1.45. This excellent rate of return indicates how competitive Swiss research is in Europe. It has therefore managed to obtain grants with a value higher than Switzerland's contribution to the RFP for the same year.[17]

T 5 Grants awarded to Swiss participants from European Union Research Framework Programmes from FP3[1]
In CHF millions, current prices

	FP3 1991–1994	FP4 1995–1998	FP5 1999–2002	FP6 2003–2006	FP7* 2007–(2013)	Total
TOTAL per FP	127	360	469	791	562	2309

[1] FP = EU Research Framework Programme
* State end of 2009

Source: SER, Rapport annuel sur la participation suisse. Berne, 2010

[16] Excluding any exchange rate variation.

[17] It must be pointed out that these figures are provisional. In fact, the final results for FP7 will not be known until the end of 2014. The figures given here come from the State Secretariat for Education and Research, "La participation suisse au 7ème programme-cadre européen de recherche, bilan intermédiaire 2007–2009 – faits et chiffres", Berne, 2010.

Federal institutes of technology as main beneficiaries of RFPs

In Switzerland the federal institutes of technology (FIT) and the four research establishments working in collaboration with the institutes of technology are the most active in terms of taking part in the RFPs. Since 1992 31% of all the Swiss participants (researchers) who received grants from the RFPs have been from this area. Participants from the university sector (higher university institutions and universities of applied sciences) accounted for 28% of the grants received.

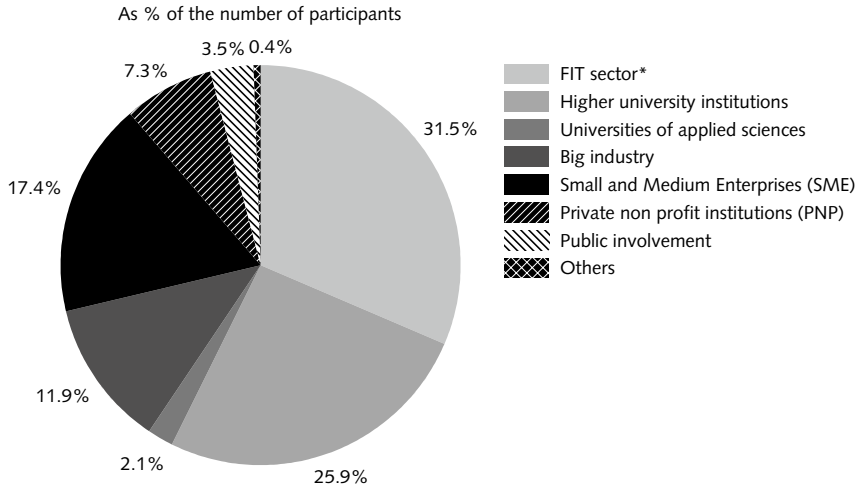
One interesting trend is that the involvement of small and medium enterprises (SMEs) has increased considerably over the years. This figure reached 17% at the end of 2009, whereas between 1991 and 1994 (FP3), SMEs only accounted for 7% of the participants.

3.3.2 International comparison

In terms of the financial commitments made by the European Union for FP6 and FP7[18], Germany, the UK and France are the main beneficiaries. The grants awarded to Switzerland were EUR 552 million for FP6 and EUR 392 million[19] for the European Union's Seventh Research Framework Programme, placing Switzerland in the middle of the pack.

In conclusion, Switzerland allocates a significant share of its budget to international research, whether for European coordinated research or RFPs. Selecting this approach shows that Switzerland is in favour of collaboration between researchers of different nationalities and of the transfer of Swiss knowledge abroad. However, it also widely benefits from the knowledge made available by foreign researchers.

Switzerland's involvement (1992–2010) from FP3 to FP7[1] according to institution **G 13**



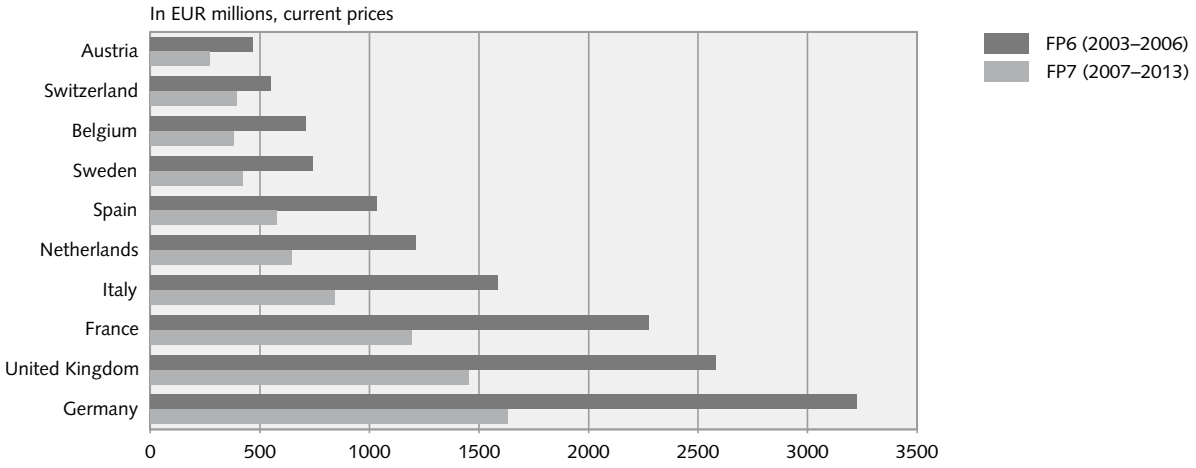
[1] FP = European Union Research Framework Programme
*FIT sector includes Zurich and Lausanne Federal Institutes of Technology, along with four research institutes Paul Scherrer Institute PSI, Federal Institute for Forest, Snow and Landscape Research (WSL), Federal Laboratories for Materials Testing land Research (EMPA) and Federal Institute for Water Planning, Purification and Protection (IFAEPE).

Source: SER, Rapport annuel sur la participation suisse. Berne, 2010

[18] The expression "financial commitments" refers to the commitments made by the European Union towards the R&D projects proposed by the researchers from the various participating countries, and not to the actual payments received by the researchers.

[19] Last report for FP7: October 2009.

European Union's financial commitments for FP6 and FP7*, international comparison **G 14**



* FP = European Union Research Framework Programme

Source: SER, Rapport annuel sur la participation suisse. Berne, 2010

The inclusion of Swiss researchers in international networks gives them access to specific expertise, sometimes only available abroad. By sharing their knowledge and technologies, all the countries can enjoy the benefits of this collaboration and take an active part in creating the European Research Area. Furthermore, involvement in the RFPs has highlighted that the competitiveness of the Swiss scientific sector enables it to receive grants from the EU for amounts which are higher than the funds contributed by Switzerland as part of the same programme, thereby automatically generating an enviable return on investment (ROI) for the Swiss scientific sector.

4 Conclusion

International exchanges of R&D as seen according to the official statistics

As part of the official statistics on R&D, a set of data was lacking combining all the indicators dealing with the various international aspects of R&D in Switzerland. This publication helps to plug this gap by analysing the various aspects of this activity.

With the aim of achieving the broadest and most complete picture possible, this analysis is not limited only to conventional means for measuring the internationalisation of Swiss enterprises. It also deals with the different forms of exchanging knowledge such as the purchase and sale of knowledge featuring in the technology balance of payments or international cooperation on research, focusing both on the attractiveness and competitiveness of the Swiss scientific sector.

The growth in R&D carried out by Swiss foreign affiliates does not equate to relocation

As far as Swiss private enterprises are concerned, the conventional measurements for internationalisation show that Switzerland enjoys a very high level of inter nationalisation in terms of R&D. This has been achieved in particular as a result of the increase in the R&D expenditure of foreign affiliates in the Pharmacy industry, which is traditionally the leading sector for R&D activities in the Swiss economy. However, this rapid growth in R&D carried out by Swiss enterprises outside Switzerland should not be interpreted as relocation. In fact, the enterprises located in Switzerland are continuing their efforts in Switzerland and invest ever-increasing sums in this activity.

The analysis of foreign-controlled affiliates established in Switzerland highlights that they only make a small contribution to the private sector's R&D effort. If this measurement is traditionally used to convey a country's attractiveness, caution must be exercised in interpreting this result. Indeed, given the exceptionally high level of R&D activity carried out by Swiss-based enterprises, it is almost natural for foreign enterprises to play a secondary role in terms of the economy's overall R&D activity.

Swiss enterprises hungry for technology

Another observation from this analysis is that Swiss enterprises consume huge amounts of R&D. With their activities heavily focused on producing goods with high technology content, they have considerable technology requirements. This means that, in spite of a sustained effort in carrying out R&D activities for their own benefit, Swiss enterprises also resort to R&D offered by the international markets to supplement their domestic provision.

Finally, the technology balance of payments indicates that the international trade in R&D has literally exploded in these last twenty years, especially since 2000. The huge growth in exports very clearly indicates how competitive Switzerland's scientific sector is on the international markets. At the same time, the dynamic expansion of imports reflects the demand Swiss enterprises have for international research products.

Switzerland has a high profile and is very competitive in the European Union's Research Framework Programmes

In terms of international cooperation, the Confederation allocates significant resources both to international coordinated research and the European Union's Research Framework Programmes.

The spin-offs from these Research Framework Programmes are considerable for Switzerland. The grants awarded by the EU as part of these RFPs are higher than the amounts contributed by Switzerland to these programmes. As these research projects are awarded on a competition basis, a higher volume of grants tends to indicate a high level of competitiveness from Swiss researchers in relation to other scientific sectors in the EU.

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