04

National Economy

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Science and technology

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Swiss Confederation

Federal Department of Home Affairs FDHA
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Neuchâtel 2015

Overview

Switzerland's gross domestic expenditure on research and development (GERD)*[1] has risen since 2000, but the rate of growth slowed down in 2012. This slowing down is mainly due to business enterprises: their behaviour with regard to research and development (R&D)* was affected by the financial crisis of 2008 and the years of uncertainty that followed in its wake. In relation to Gross domestic product (GDP), Switzerland's R&D expenditure is among the highest of OECD[2] countries. The private sector remains the main stakeholder in R&D, but support from the Confederation is increasing over time, demonstrating the State's determination to encourage research in Switzerland.

R&D personnel increased continuously during the period under observation (2000-2012). The participation of women in research also increased as did the proportion of foreign researchers.

In Switzerland, the financial effort and the increase in personnel involved in R&D is rewarded by remarkable scientific results, the benefit of which is felt directly by certain sectors of the economy. Although the financial crisis had a temporary effect on R&D, Switzerland continues to be very attractive as a research and development centre.

[1] Terms marked with an asterix are explained in the glossary at the end of the brochure.
[2] OECD: Organisation for Economic Cooperation and Development.

CONTENTS

1. Introduction

Importance of science and technology

Science and technology (S&T) contributes to almost every aspect of modern life. As a source of innovation and an essential element in transferring knowledge and putting it to use, scientific and technological systems play a decisive role in strengthening the competitiveness and growth of national economies.

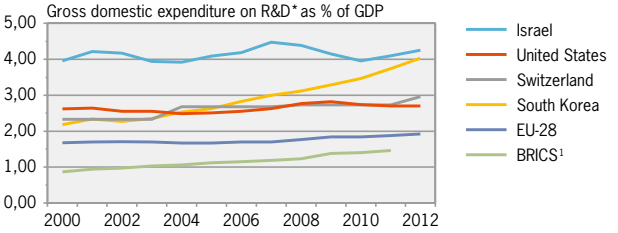
For the definition of S&T goals and also for their subsequent evaluation, national stakeholders (the Confederation, enterprises, higher education institutions,...) need firstly to refer to an overview of the Switzerland's entire S&T system* and secondly to identify structural changes and trends in this field. The S&T indicators allow these phenomena to be measured objectively.

This publication presents a selection of indicators which enable an assessment of the Swiss S&T system (2012) and to measure developments within the system since 2000. By examining the performance of this system using international comparisons and highlighting its successes but also its shortcomings, the indicators shown here enable monitoring of progress made in this field and a better evaluation of what remains to be done.

2. Swiss R&D's place in the world

*The research and development (R&D)** indicators are a sign of the importance a country attaches to the development of its S&T system.

R&D intensity by country and by region, 2000–2012



[1] BRICS: Brazil, Russia, India, China, South Africa / BRICS 2000 and 2002: excl. South Africa

Sources: OECD – MSTI database, July 2015; UNESCO; FSO – Swiss RD

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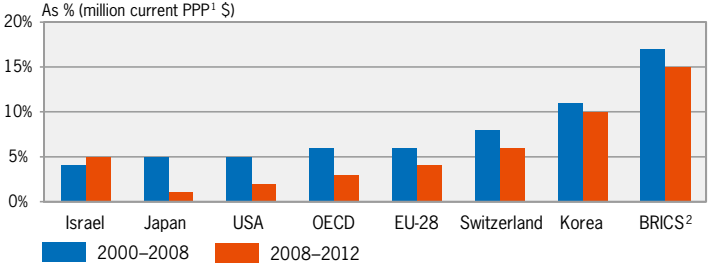
Israel is the country which devotes the largest percentage of its GDP to R&D. Switzerland's R&D intensity is close to that of the United States but its growth rate is higher. Almost all countries saw a decline in their growth rate after 2008.

Average annual growth rate of R&D expenditure by country and by region, 2000–2008 and 2008–2012



[1] PPP: Purchasing power parities [2] BRICS: Brazil, Russia, India, China, South Africa / BRICS: 2001–2008 and 2008–2011

Sources: OECD – MSTI database, July 2015; UNESCO; FSO – Swiss RD

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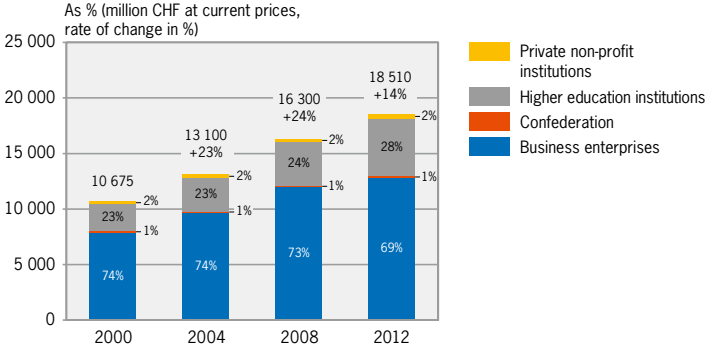
3. R&D performance

Research and development (R&D)* plays an important role in competitiveness and economic growth. R&D efforts are measured by *R&D performance indicators:* the volume of R&D investment, but also the role of different economic stakeholders.

Intramural R&D expenditure* in Switzerland by sector of economic activity, 2000–2012

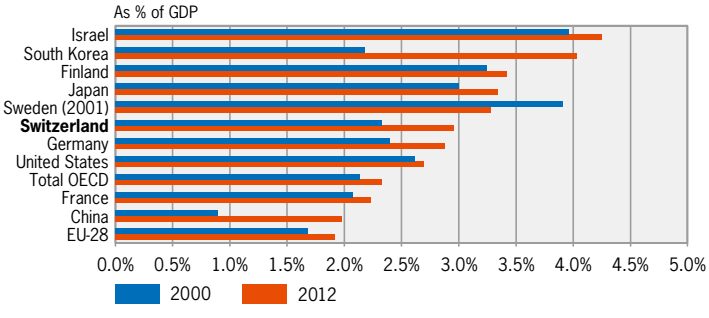


Source: FSO – Research and development (R&D) Swiss synthesis (Swiss RD) © FSO 2015

During the period observed, intramural R&D expenditure* increased constantly in Switzerland. In 2012, it amounted to CHF 18.5 billion but the rate of change declined in comparison with the previous period.

Although its share fell slightly in 2012 (69%), the business enterprise sector remains by far the largest investor in R&D in Switzerland. The role played by higher education institutions has increased since 2008.

Gross domestic expenditure on R&D*, international comparison, 2000 and 2012

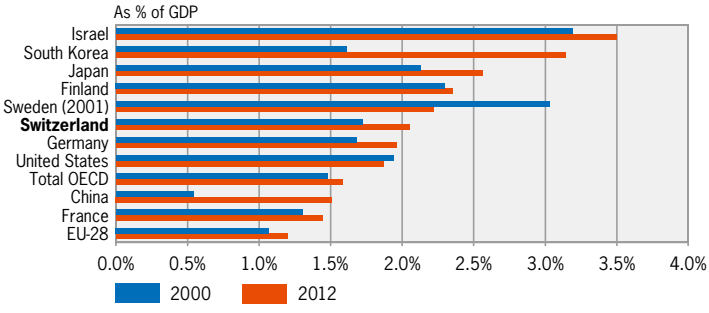


Source: OECD database MSTI, STI division/EAS Paris, July 2015 © FSO 2015

Switzerland is one of the countries spending most on R&D in relation to their GDP. Switzerland's R&D effort has been increasing for 12 years and it continues to hold its position with the leading OECD countries.

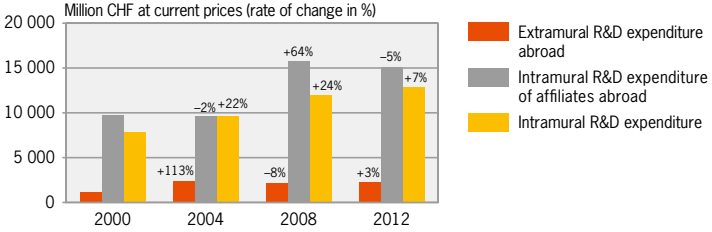
As the main stakeholders in R&D in Switzerland are enterprises, Switzerland maintains its good position when an international comparison is made of R&D expenditure by the enterprise sector alone.

Gross domestic expenditure on R&D* by the business enterprise sector, international comparison, 2000 and 2012



Source: OECD database MSTI, STI division/EAS Paris, July 2015 © FSO 2015

Business enterprises R&D expenditure in Switzerland and abroad, 2000–2012

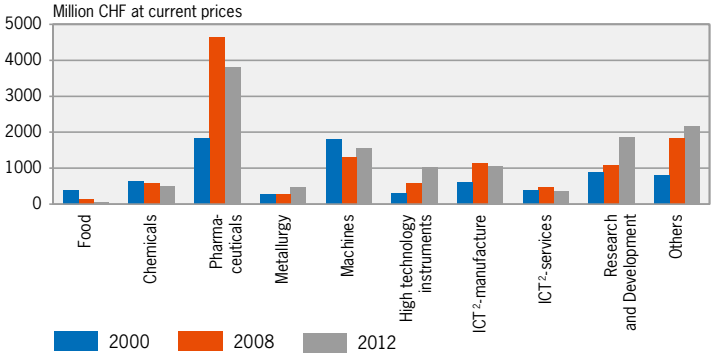


Source: FSO – Research and development (R&D) in private enterprises (RD enterprises) © FSO 2015

The financial crisis of 2008 affected enterprise R&D. In 2012, intramural R&D expenditure* increased by only 7% (+24% in the previous period) and the R&D expenditure of affiliates abroad fell.

R&D is not equally important in all industries. For some industries, such as „Pharmaceuticals", R&D is indispensable. It is the heavy-weight of R&D in Switzerland.

Business enterprises intramural R&D expenditure* in Switzerland by industry[1], 2000, 2008 and 2012



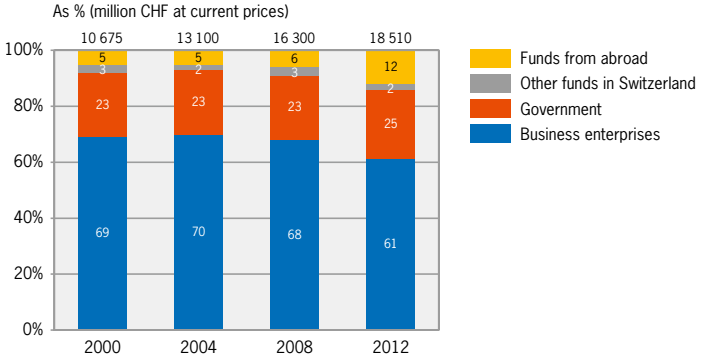
[1] NOGA economic branches [2] ICT: Information and communication technologies

Source: FSO – Research and development (R&D) in private enterprises (RD enterprises) © FSO 2015

4. R&D funding

National R&D effort is defined not only by R&D stakeholders and their expenditure but also by funders of R&D. *The R&D funding indicators* focus attention on the origin of funds granted for the performance of R&D.

Funding of intramural R&D expenditure* performed in Switzerland by source of funding, 2000–2012



Source: FSO – Research and development (R&D) Swiss synthesis (Swiss RD)

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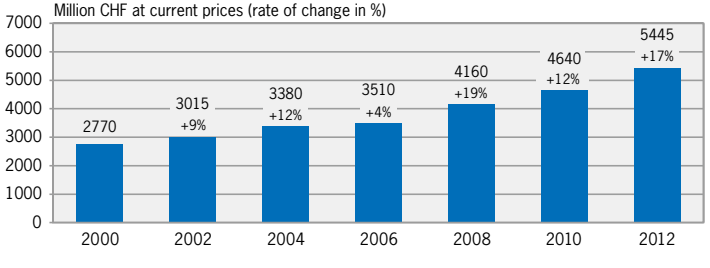
Over the period considered here, the main funder of R&D in Switzerland was the business enterprise sector. In 2012, this sector funded 61% of R&D performed in Switzerland. This percentage fell slightly compared with 2008, in favour of public and foreign funding.

Government budget appropriations or outlays for R&D* in Switzerland, 2000–2012

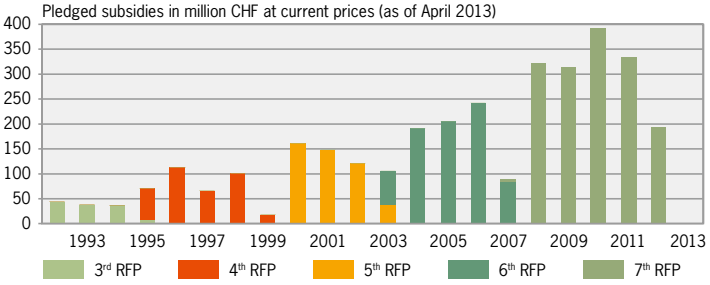


Source: FSO – Research and development (R&D) in private enterprises (RD Confederation) © FSO 2015

Government budget appropriations or outlays for R&D (GBAORD)* correspond to the part of the budget that the government designates to R&D. They allow public R&D funding to be described over time. There is a constant increase in R&D funding over the whole period under consideration.

After the Swiss National Science Foundation (SNSF), the second source for direct public funding of research in Switzerland are the European Union (EU) framework programmes for research, a real driving force for national R&D.

RFP subsidies[1] to Swiss participants in 3rd to 7th RFP[1], 1992–2013



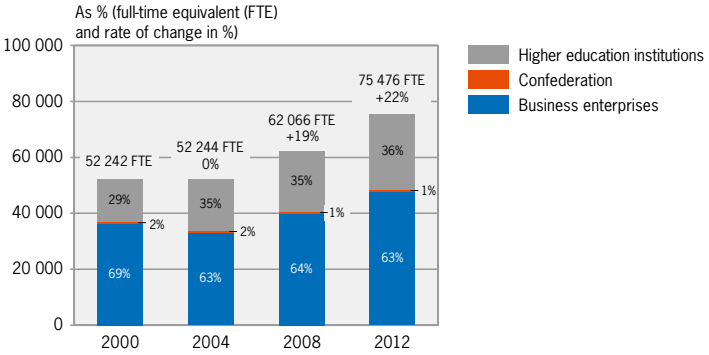
[1] RFP: European Union Framework Programmes for Research

Source: SERI, Annual report on Swiss participation Bern, 2013 © FSO 2015

5. R&D personnel

The R&D personnel indicators show the importance of the stock of human capital a country can count upon for the development of its R&D and its S&T system*.

R&D personnel in Switzerland by sector of economic activity, 2000–2012



Source: FSO – Research and development (R&D) Swiss synthesis (Swiss RD)

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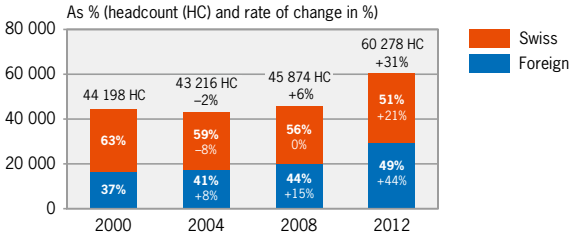
In Switzerland, the number of persons employed in R&D has increased by 44% in 12 years. In 2012, 63% of this personnel was concentrated in the business enterprise sector.

R&D personnel can be broken down into three categories on the basis of the occupations carried out: researchers, technicians and support staff.

In 2012, the greatest share of R&D personnel were researchers at 48%.

Researchers in Switzerland by nationality, 2000–2012

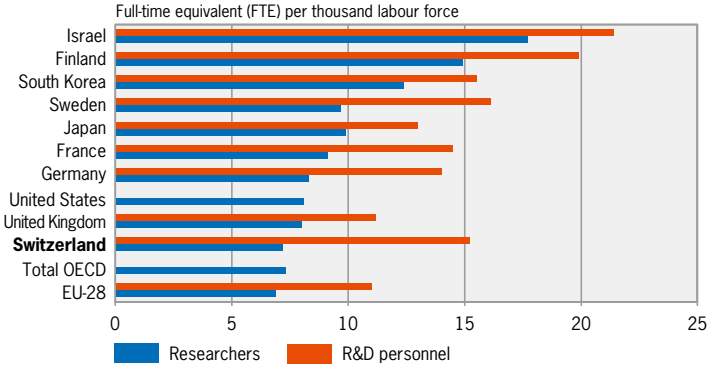


Source: FSO – Research and development (R&D) Swiss synthesis (Swiss RD) © FSO 2015

The growth in the number of researchers in Switzerland is accompanied by an increase in the number of foreign researchers. The latter represent an ever greater share of researchers in Switzerland. In 2012, they constituted almost half of this category (49%).

In international comparison, the percentage of R&D personnel among the Swiss labour force was relatively high, placing Switzerland in the top group of OECD countries. However, Switzerland's position is weaker in terms of numbers of researchers.

R&D personnel and researchers, international comparison, 2012

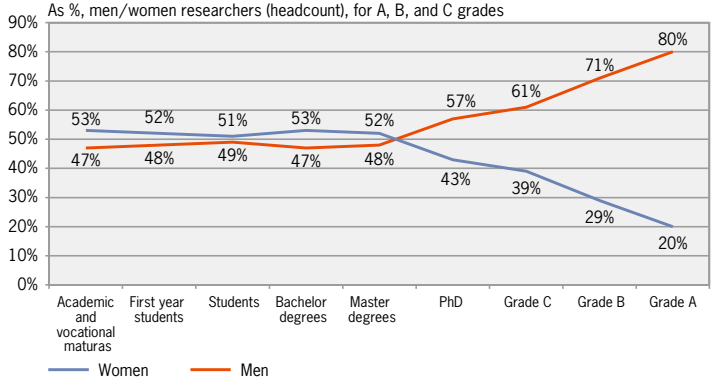


Source: OECD database MSTI, STI division/EAS Paris, July 2015 © FSO 2015

6. Participation of women in S&T

In order for the S&T system* to benefit from the stock of talent formed by trained women, their integration at all scientific career levels is fundamental. *The indicators of female participation in S&T* are a reminder of the role of women in the development of the S&T system and of R&D in particular.

Leaky pipeline
Career of men and women researchers in the higher education institutions[1] in Switzerland, 2012



[1] Higher education institutions: Cantonal universities, federal institutes of technology, universities of applied sciences and universities of teacher education.

Source: FSO, SHIS – Swiss Higher Education System statistics

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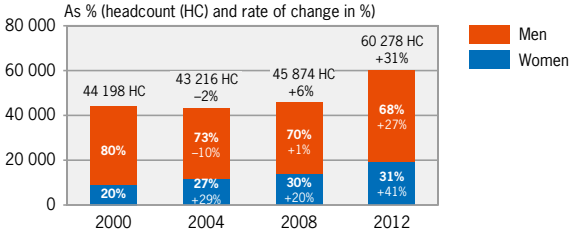
The journey of women embarking on a scientific career can be compared to a leaky pipeline. Within higher education institutions, in particular, the number of women declines the higher up the academic career ladder one climbs. Despite the feminisation of the student population, a noteworthy phenomenon of the past 30 years, men once again dominate from the doctorate stage. In 2012, 36.3% of researchers in the higher education sector in Switzerland were women; this percentage fell to 20% when focusing on researchers at the height of their career (grade A).

Researchers in Switzerland by sex, 2000–2012

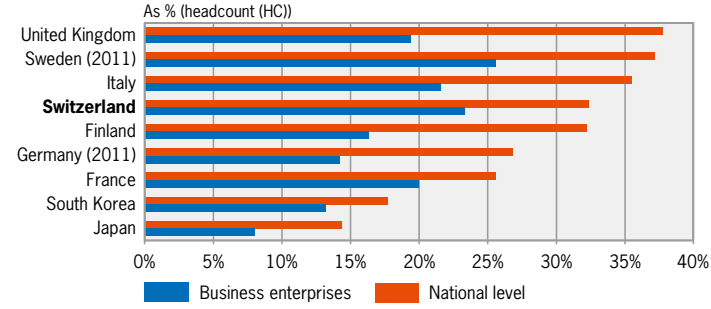


Source: FSO – Research and development (R&D) Swiss synthesis (Swiss RD) © FSO 2015

Few researchers are women. In 2012, they formed 32% of personnel. However, their numbers are fast increasing, at a higher rate than that of men. In 12 years, their numbers have more than doubled.

Women constitute a minority among researchers in most OECD countries. In international comparison, Switzerland came in the middle of the pack in 2012. In the business enterprise sector, the percentage of women is even smaller.

Women researchers as a percentage of all researchers, at national level and in the business enterprise sector, international comparison, 2012

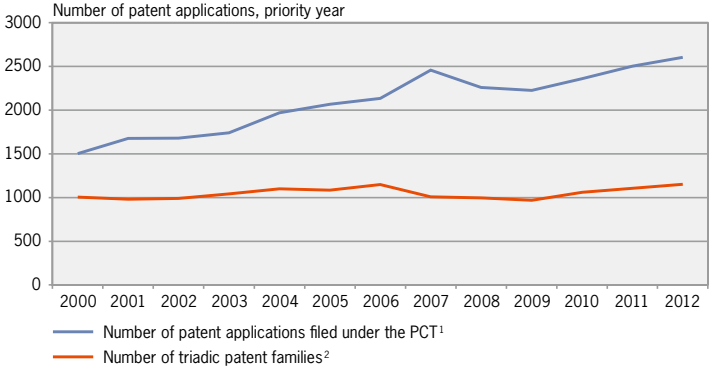


Source: OECD – MSTI database, STI/EAS division, Paris, July 2015 © FSO 2015

7. S&T production

The *S&T production indicators* highlight the efforts of S&T stakeholders in Switzerland for the development and transfer of knowledge in the form of patents and scientific publications.

Patent* applications of Swiss inventors, 2000–2012



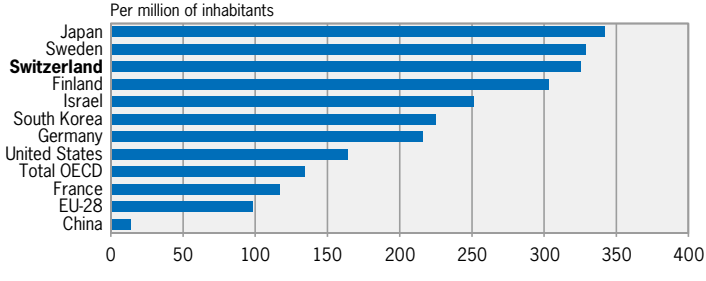
[1] Patent Cooperation Treaty. The treaty enables applicants to request the protection of a patent simultaneously in a large number of countries by filing one "international" patent application. The treaty is open to member states of the Paris Convention for the Protection of Industrial Property (1883).

[2] A patent family is made up of all the patents filed in several countries for a single invention. Triadic patent families are made up of all patents filed with the European Patent Office (EPO), the Japanese Patent Office (JPO), and patents issued by the United States Patent and Trademark Office (USPTO).

Source: OECD – MSTI database STI division/EAS, Paris, July 2015 © FSO 2015

The number of patent* applications filed under the PCT* and the number of triadic patent families* from Swiss inventors has increased since 2000. Growth has been slower with regard to triadic patent families*, for these are a selection of patents* of higher value. The global financial crisis had an impact on the capacity for innovation in Switzerland. This can be seen in the curve for patents applications. Patenting activities declined considerably in 2008 and 2009 compared with their level in 2007. An upturn can be seen from 2010.

Patent* applications filed under the PCT[1], international comparison, 2012

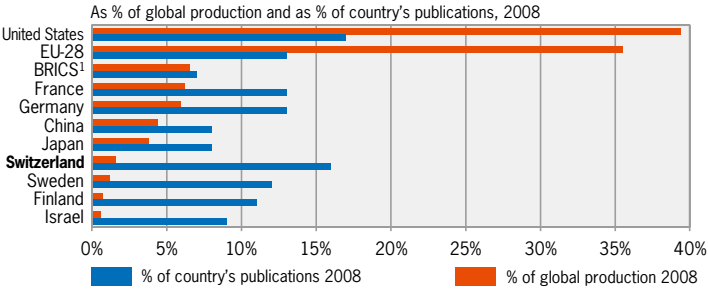


Source: OECD – MIST database STI division/EAS, Paris, July 2015 © FSO 2015

Due to its small size, Switzerland only holds a small share of all patents filed in the world. However, in relation to the number of inhabitants, Switzerland is one of the countries most active in this field.

Switzerland produces 1.6% of the most-cited publications worldwide (Top 10%*), which corresponds to 16.4% of all the scientific publications produced in Switzerland; it is the second biggest percentage after the United States (16.6%).

Most-cited scientific publications (Top 10%*), international comparison, 2008



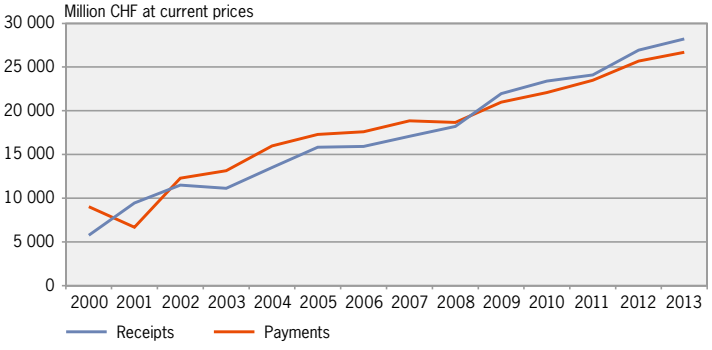
[1] BRICS: Brazil, Russia, India, China, South Africa

Source: Most-cited publication: Switzerland's performance, 1997–2011, SERI report 2015 © FSO 2015

8. S&T impact

The indicators of S&T impact show how the efforts made by researchers in Switzerland to promote knowledge and innovation are transformed into economic results.

Swiss technology balance of payments, 2000–2013



Source: OECD – MIST database, STI/EAS division, Paris, July 2015

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The technology balance of payments (TBP) is an account of the dissemination of technological knowledge by the purchase and sale of disembodied technology (such as patents*, R&D technical cooperation). Purchases and sales of disembodied technology increased in Switzerland throughout the period 2000-2012. The TBT* balance remained negative (payments exceed receipts) from 2000 to 2008 (except for the year 2001). Since 2009, the TBP balance has been positive and apart from a decline in 2011, it is tending to increase, thus reflecting Switzerland's capacity to spread its knowledge beyond its boundaries.

9. Key Swiss R&D figures

Intramural research and development (R&D) expenditure	Million Swiss francs (CHF) at current prices and relative shares							
	2000		2004		2008		2012	
	Total	%	Total	%	Total	%	Total	%
Business enterprises	7 890	74%	9 660	74%	11 980	73%	12 820	69%
Confederation	140	1%	140	1%	120	1%	140	1%
Higher education institutions	2 440	23%	3 000	23%	3 940	24%	5 210	28%
Private non-profit institutions	205	2%	300	2%	260	2%	340	2%
Total R&D expenditure	**10 675**	**100%**	**13 100**	**100%**	**16 300**	**100%**	**18 510**	**100%**
Intramural R&D funding	Million CHF at current prices and relative shares							
Business enterprises	7 335	69%	9 135	70%	11 115	68%	11 250	61%
Confederation	2 480	23%	2 975	23%	3 725	23%	4 705	25%
Other funds in Switzerland	365	3%	305	2%	490	3%	320	2%
Funds from abroad	495	5%	685	5%	970	6%	2 235	12%
Total R&D funding	**10 675**	**100%**	**13 100**	**100%**	**16 300**	**100%**	**18 510**	**100%**
R&D personnel (FTE)	Full-time equivalent (FTE) and relative shares							
Business enterprises	36 182	69%	33 084	63%	39 832	64%	47 750	63%
Confederation	862	2%	808	2%	809	1%	781	1%
Higher education institutions	15 198	29%	18 352	35%	21 425	35%	26 945	36%
Total R&D personnel	**52 242**	**100%**	**52 244**	**100%**	**62 066**	**100%**	**75 476**	**100%**
Researchers (HC)	Headcount (HC)							
	Total	Women	Total	Women	Total	Women	Total	Women
Business enterprises	17 452	2 261	13 962	2 938	11 237	2 101	17 904	4 177
Confederation	738	145	958	245	1 034	337	980	326
Higher education institutions	26 008	6 578	28 296	8 368	33 603	11 408	41 395	15 037
Total researchers	**44 198**	**8 984**	**43 216**	**11 551**	**45 874**	**13 846**	**60 279**	**19 540**

Government budget appropriations or outlays for R&D (GBAORD)	Million CHF at current prices						
	2000	2002	2004	2006	2008	2010	2012
Total	**2 770**	**3 015**	**3 380**	**3 510**	**4 160**	**4 640**	**5 445**

Source: FSO – Research and development (R&D) Swiss synthesis (Swiss RD)

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10. Glossary

Terms appearing in the glossary are marked with* in the text.

Intramural R&D expenditure: All expenditure designated for R&D performed in a unit within its walls, during a given period.

Government budget appropriations or outlays for R&D (GBAORD): GBAORDs cover all state-funded R&D expenditure.

Gross domestic expenditure on R&D (GERD): Total of intra-mural R&D expenditure performed on the national territory during a given period.

Patent: A patent is a right of intellectual property pertaining to inventions of a technical nature. It can be granted to an enterprise, to an individual or to a public body by a patent office, in exchange for the publication of its invention.

Patent Cooperation Treaty (PCT): The treaty enables applicants to request the protection of a patent simultaneously in a large number of countries by filing one „international" patent application.

Research and development (R&D): R&D comprises creative work undertaken on a systematic basis in order to increase the stock of knowledge including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications. (OECD, Frascati Manual, 2002)

Science and technology system (S&T): All institutions connected to the economy, politics and society whose aim is to increase knowledge and the wealth of one's community by promoting a culture of innovation as well as the competitiveness of ones enterprises and institutions based upon knowledge.

Top 10% of most-cited publications: The most-cited publications are those most often cited by researchers. To calculate these publications, all publications were classified by scientific sub-groups, by year and by decreasing order of citations. Only the first 10% were kept.

Triadic patent family: A patent family is made up of all the patents filed in several countries (i.e. patent offices) to protect the same invention. Triadic patent families are made up of all patents filed in three of the main offices, i.e. the European Patent Office (EPO), the Japanese Patent Office (JPO) and the United States Patent and Trademark Office (USPTO).

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