

# 2016 Research and Innovation in Switzerland





## Reconstruction and Simulation of Neocortical Microcircuitry

This image illustrates the joint effort between engineers and scientists to digitally reconstruct and simulate the rodent brain. It was designed to illustrate Blue Brain's first draft digital reconstruction of neocortical microcircuitry (Markram et al, 2015), a paper published in the scientific journal, Cell. Only two percent of the neurons are visible here. The composition focuses on a group of pyramidal neurons on layer 5 of the neocortex. Their apical dendrites guide the viewer up towards layer 1 cells in the light shone from above, revealing the microscopic and complex neural architecture of the brain.

The aim of the Blue Brain Project, a Swiss brain initiative founded by Professor Henry Markram, is to build accurate, biologically detailed digital reconstructions and simulations of the rodent brain, and ultimately, the human brain. The supercomputer-based reconstructions and simulations built by Blue Brain offer a radically new approach for understanding the multilevel structure and function of the brain.



# Management Summary

## Swiss Universities – A Wide Range of High-Quality Options

With its cantonal universities and federal institutes of technology (ETH/EPF), its universities of applied sciences and universities of teacher education, the Swiss higher learning landscape offers a wide diversity of options.

Degree courses are structured according to the international model, with Bachelor and Master levels. All universities are involved not only in teaching but also in research and continuing education and training and provide services to third parties.

International ranking of Swiss universities

|                                 | EPFL | ETHZ | Basel   | Bern    | Fribourg | Geneva | Lausanne | Neuchâtel | St.Gallen | Zürich |
|---------------------------------|------|------|---------|---------|----------|--------|----------|-----------|-----------|--------|
| Shanghai Ranking 2016 (Top 500) | 92   | 19   | 101–150 | 101–150 | 301–400  | 53     | 201–300  |           |           | 54     |
| QS Ranking 2016 (Top 500)       | 14   | 8    | 141     | 181     |          | 95     | 138      |           | 288       | 80     |
| Times Ranking 2016 (Top 800)    | 30   | 9    | 98      | 110     | 251–300  | 137    | 151      | 401–500   | 401–500   | 106    |

Source: [www.universityrankings.ch](http://www.universityrankings.ch)

## Well-Coordinated Cooperation Between the Private and Public Sectors

A division of tasks between the private and public sectors has evolved over time, where basic research is conducted mainly in ETH and cantonal universities, and applied research and development (aR&D) and the development of marketable products takes place primarily in the private sector and at universities of applied sciences.

The federal government funds research and innovation through the Swiss National Science Foundation (SNSF) and the Commission for Technology and Innovation (Innosuisse as of 2018).

Swiss universities are internationally recognised for their achievements and make a significant contribution to the economic, cultural and social development of the country.

Approximately a quarter of all students and over 40% of researchers at Swiss universities are foreign nationals. Various universities place well or even very well in international rankings.

The Confederation also funds the ETH Domain and the Swiss Academies of Arts and Sciences, and supports almost 30 research facilities outside the university sector. The cantons support primarily their own cantonal universities and universities of applied sciences.

Around two thirds of all R&D in Switzerland is funded by the private sector and takes place mainly within a relatively small group of very research-intensive large companies and particularly innovative SMEs.

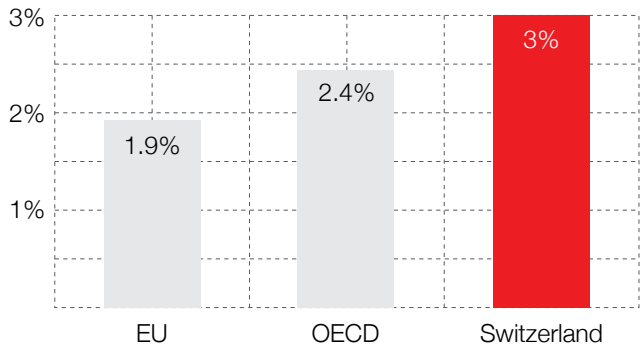
## Established Principles in Research and Innovation Promotion

Public research promotion primarily relies on openness, the researchers’ own initiative, the principle of competition, qualitative assessment criteria and international cooperation.

- Openness: there are few specifications established by the government for research topics and programme funding. Universities enjoy a high degree of autonomy. All disciplines are eligible for funding.
- Bottom-up principle: individual research teams or companies are proactive in their research and innovation activities. They take responsibility and accept risks.
- Competitiveness and excellence: funding is awarded in a competitive proposal process; proposals are evaluated according to their standard of excellence.
- International cooperation: Switzerland actively contributes to international research organisations and programmes.

Both the government and the private sector invest large amounts in maintaining and developing Switzerland as a research location. Investment in research and innovation makes up around 3% of Swiss GDP – a figure much higher than the OECD average.

R&D expenditure as a percentage of GDP, 2013



Exceptions to reference year 2013: Switzerland: 2012  
Source: OECD

## Active Cooperation in International Research and Innovation

Switzerland’s main involvement is in the European Research Framework Programmes (Horizon 2020) and the EU’s education and mobility programmes (ERASMUS+).

Switzerland is active in key European research and innovation initiatives such as COST and EUREKA. Furthermore, it is a member of several international research organisations such as the European Space Agency (ESA) and CERN, the world’s largest laboratory for elementary physics, based in Geneva.

Foreign science policy is an integral part of Swiss foreign policy; Switzerland works bilaterally with select partner countries, and is present in an official capacity all over the world, with its science and technology councillors at Swiss embassies and through the swissnex network.

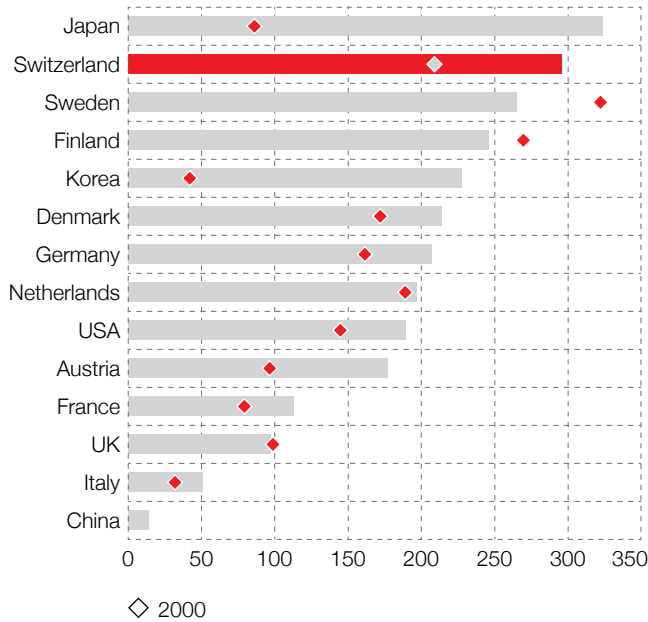
## Optimal Framework for Innovation-Intensive Companies

A competitive market with a strong focus on private initiative and comparatively little state regulation and intervention are the key features of the system in Switzerland.

Switzerland has particularly clear regulations to protect intellectual property. The fiscal environment is generally favourable. The processes and requirements for setting up a new company in Switzerland are favourable compared to many other countries.

Switzerland is a leader with regard to PCT patents. Measured against the country’s population, the number of patent applications is particularly high.

PCT patent applications per million inhabitants, 2013



## Qualified Specialists Along the Entire Value Chain

Switzerland has a highly developed education system. Young people and adults can pursue either a vocational or an academic education path, depending on their strengths and talents. The education system has high permeability, allowing transfers both within and between the vocational and academic areas of education.

Companies in Switzerland benefit from highly qualified specialists and executives along the entire value chain. Unemployment is low.



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# Preface

Switzerland is the most innovative country in the world, according to various innovation rankings such as the European Innovation Scoreboard and the Global Innovation Index. This is remarkable, considering that these rankings are in absolute terms, providing a holistic appreciation of the innovation systems around the globe. But what is behind Switzerland's success as an innovative nation?

The fact that the public sector does not forcefully steer innovation or industry politics in the narrower sense is probably the real secret of Switzerland's success. Innovation springs up and blooms in the private sector where creative minds understand how to transform ideas and discoveries into products and services. Innovative firms identify market potential, develop markets and create jobs and prospects for people.

The role of the federal government is to provide a fertile environment for innovation actors. This includes Switzerland's first-class education system with its strong dual-track vocational model and excellent, internationally renowned universities, such as the Federal Institute of Technology in Zurich, which is ranked among the top 10 universities in the world. But it also includes outstanding research institutions such as PSI and CERN, efficient promotion and funding instruments, as well as public-private partnerships. Besides education and research, other framework conditions also play a key role, such as a very open labor market, modern infrastructures, an attractive tax system as well as the level of safety and quality of life that Switzerland offers.

This brochure aims at providing a solid and concise overview of Switzerland's outstanding innovation capacity. It identifies the diverse parameters, explains interactions, provides facts and figures and makes comparisons with other countries. By shedding light into Switzerland's innovation system, I hope the brochure may contribute to more transnational collaboration and encourage future joint innovative solutions to counter global challenges.

I wish you a stimulating read.



Jean-Jacques de Dardel, Ph.D.  
Ambassador of Switzerland to China





# The Swiss Innovation System

## High-tech Made in Switzerland

Rolic Technologies Ltd is an innovative high-tech company that operates world-wide and is based in Switzerland. It develops and sells ready-to-use coating materials and other types of functional foils for screens, security elements and for sealing highly sensitive products. Rolic's core competency is light management. With its patent-protected LCMO technology (Light Controlled Molecular Orientation) Rolic modifies surfaces on a nano scale with polarized light to achieve unique optical effects. As part of a CTI project, Rolic developed a new security element for banknotes and other documents in collaboration with the NTB Technical University in Buchs.



# 1 Context and Responsibilities

## 1.1 General Context

The bottom-up approach is one of the principles of public research and innovation promotion: firms or individual research teams take the initiative for research and innovation activities and themselves assume the responsibilities and risks. Key to the promotion system is project funding by the Swiss National Science Foundation (SNSF) and CTI. They allocate funding on a competitive basis and make their assessments on the basis of excellence. By international standards, Switzerland is reluctant to dictate, from the top down, the areas and programmes that are eligible for funding. Moreover, funding is not, as a rule, granted directly to companies.

Further hallmarks include the flexibility and adaptability of the actors in the business and higher education sectors, the rapid diffusion of innovations via science and business networks, as well as efforts to maintain Switzerland's considerable attractiveness as an education and research centre for talents and qualified professionals from all over the world.

The state promotes an education system that is founded on a complementary mix of vocational and academic training options. At the same time, the Swiss education system is also highly flexible both within and between the vocational and academic teaching sectors. These elements facilitate the training of well-qualified specialists and equip them to work along the entire value chain, a factor that is instrumental to Switzerland's research and innovation achievements.

Switzerland has a competitive market economy driven by private initiative with – by international standards – relatively little government regulation and intervention. The various markets for labour, capital, goods and services are largely competition-driven; thanks to multilateral and bilateral agreements, access to international markets is free and open. This affords the business sector a high degree of flexibility and mobility and enables it to rapidly absorb change. Switzerland also has clear regulations in place to protect intellectual property. The fiscal environment is relatively attractive, with no particular preferential treatment for research and innovation. Framework conditions to launch a business in Switzerland are at the top end of the middle range compared with other countries.

## 1.2 Responsibilities

Public research and innovation promotion essentially falls within the domain of the federal government. The scope and organization of the federal government's research and innovation promotion tasks are framed by the Federal Act on the Promotion of Research and Innovation (RIPA). It covers national as well as international promotion tasks undertaken by the federal government. Furthermore, it defines the tasks, procedures and responsibilities of the promotion bodies.

In accordance with the Federal Act on Funding and Co-ordination of the Swiss Higher Education Sector (HEdA), the federal government – working in concert with the cantons – ensures the quality and competitiveness of Switzerland's entire higher education sector, which, on the strength of its commitment to research, makes major contributions to downstream innovation activities.

The key actors and institutions responsible for research and innovation promotion at federal level are the Federal Department of Economic Affairs, Education and Research (EAER), the State Secretariat for Education, Research and Innovation (SERI), the State Secretariat for Economic Affairs (SECO), as well as the Board of the Federal Institutes of Technology (ETH Board), representing the institutions of the ETH Domain. Other departments such as the Federal Department of the Environment, Transport, Energy and Communications (DETEC) are also directly or indirectly engaged in research and innovation promotion. The Swiss Science and Innovation Council (SSIC) is the advisory body to the Federal Council for all research and innovation policy issues.

As responsible bodies for the universities, universities of applied sciences (UAS) and universities of teacher education (UTE), the cantons are also involved in research and innovation promotion. The universities, UAS and UTE themselves also number among the research and innovation actors. They enjoy a considerable amount of autonomy and are self-organising. Cities and municipalities play a role in innovation promotion, for instance by building technology and innovation parks.

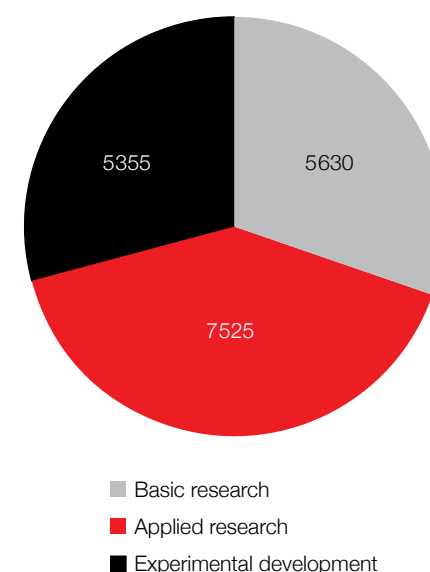
# 2 Research and Innovation Funding, Performing and Actors

Research and development (R&D) activities totalling CHF 18.5 billion were carried out in Switzerland in 2012. This corresponds to around 3% of the country's gross domestic product (GDP), placing Switzerland among the OECD's top R&D spenders.

Figure A 2.1 shows that the biggest share (41%, or CHF 7.5 billion) went to applied research. Basic research (CHF 5.6 billion) and experimental development (CHF 5.4 billion) each accounted for almost 30%.

Roughly two thirds of R&D expenditure in Switzerland are funded and performed by the private sector, in large part by a small number of big corporations. Numerous small and medium-sized enterprises (SMEs) are also key players in the development sector.

Figure A 2.1: Intramural R&D expenditure in Switzerland by research category, in CHF million, 2012<sup>1</sup>

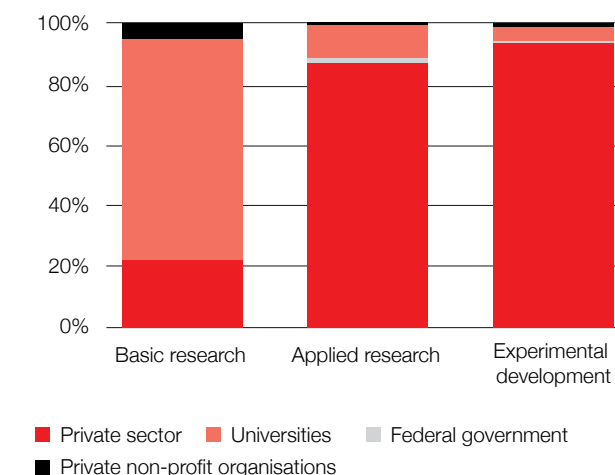


Source: FSO

Both R&D expenditure and R&D personnel reveal a high degree of internationalisation in the private sector and at universities. Switzerland is very open in this regard compared with other countries. This kindles intense international competition in Switzerland as a research hub and makes the domestic research and innovation system stronger.

Figure A 2.2 shows that the bulk of basic research is performed by the universities, which are largely publicly funded. By contrast, the private sector chiefly funds applied research and experimental development.

Figure A 2.2: Intramural R&D expenditure in Switzerland by sector and research category, 2012



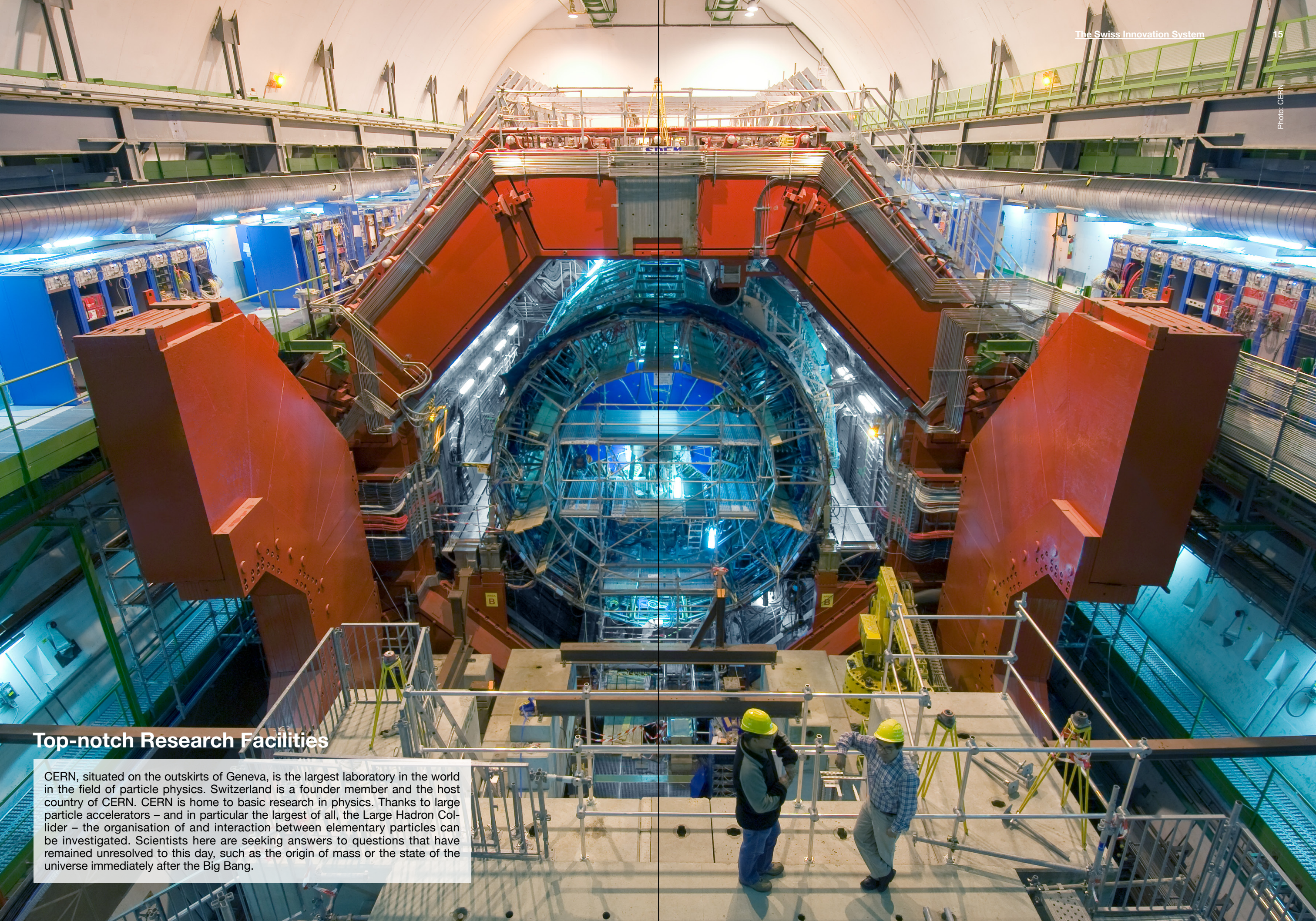
Source: FSO

<sup>1</sup> The term "intramural R&D expenditure" refers to all expenditure on R&D activities which an actor performs on their own premises, i.e. "within their own walls". In Switzerland, total intramural R&D expenditure refers to overall expenditure invested in R&D by the private sector, the federal government, universities and private non-profit organisations



## Top-notch Research Facilities

CERN, situated on the outskirts of Geneva, is the largest laboratory in the world in the field of particle physics. Switzerland is a founder member and the host country of CERN. CERN is home to basic research in physics. Thanks to large particle accelerators – and in particular the largest of all, the Large Hadron Collider – the organisation of and interaction between elementary particles can be investigated. Scientists here are seeking answers to questions that have remained unresolved to this day, such as the origin of mass or the state of the universe immediately after the Big Bang.





## 2.1 Flows of Funds in the R&D Sector

The business sector, the public sector, universities and other countries are all involved in both funding and performing R&D activities. It is possible for R&D activities to be funded from Switzerland and performed abroad, and vice versa. Universities and companies may also perform their R&D themselves or mandate outside actors to carry it out. Some research and innovation work is performed on a collaborative basis under national and international partnerships between companies, or between companies and public universities (public-private partnerships, PPP).

Figure A 2.3 provides an overview of the flows of funds between the individual sectors (data from 2012). It shows total flows of R&D funds in Switzerland and the volume of funding coming from or going abroad. The sources of funding for Swiss R&D are named on the left. The right-hand column shows the four sectors in Switzerland in which R&D is performed, plus one box for Swiss R&D activities outside Switzerland.

### Private Sector

The private sector contributed the lion's share within Switzerland's R&D realm in 2012, both in terms of funding (totalling CHF 13.5 billion, consisting of CHF 11.25 billion for R&D in Switzerland and CHF 2.28 billion for R&D abroad) and performing (CHF 12.8 billion). Companies largely funded their own R&D activities themselves, although the self-financed proportion was down from 87% (2008) to 79% (2012).

In 2012, the private sector provided CHF 2.3 billion in funding for R&D performed beyond the Swiss border. Companies have been increasingly buying in R&D abroad since 2000. What is more, affiliate of Swiss companies abroad carried out CHF 15 billion in R&D in 2012 (see Section 2.2).

### Public Sector (Federal Government and Cantons)

The public sector is engaged mainly in R&D funding. In 2012, the federal government and the cantons together funded 25% of national R&D activities. However, the federal government itself only carried out research amounting to 1% of total R&D expenditure in Switzerland. Of the CHF 5.4 billion in public funds, CHF 4.2 billion went to universities (CHF 2.34 billion from the federal government and CHF 1.83 billion from the cantons), with the remainder channelled into other areas. The federal government also financed international instruments of research promotion and collaboration in an amount of CHF 730 million, essentially comprising membership fees payable to international programmes and organisations. The main recipients were the European Union Framework Programmes for Research (FPs), the European Space Agency (ESA) and

the European Organization for Nuclear Research (CERN). In return, these membership fees benefit researchers in Switzerland in the form of project grants and access to international networks and infrastructures.

Financed primarily with public funds, the universities are engaged mainly in the conduct of R&D. In 2012, universities invested CHF 5.2 billion in R&D, representing a share of 28% in gross domestic R&D expenditure. Over 80% of funds came from the public sector, as opposed to 10% covered by companies domiciled in Switzerland. FP subsidies paid to Swiss research groups represent a key source of third-party funding as well as a strategic element of research promotion at universities. The FPs complement national research promotion: Thanks to their systematic focus on international research collaboration, the FPs are designed to and indeed do provide a strong complement to the national instruments of research funding in place. These in turn play a crucial part in building up the capabilities needed to qualify for international funding.

### Outside Switzerland

Actors from outside Switzerland provided CHF 2.2 billion in funding for research projects carried out in Switzerland in 2012. This corresponds to 12.1% of total expenditure on R&D in Switzerland and represents a significant increase in the previous ten years.

Almost CHF 2 billion of this amount was used for R&D in the private sector, chiefly in the form of mandates from companies within the same group. Universities received CHF 250 million from abroad in the same year. As mentioned above, these funds came primarily from European Union Framework Programmes. Conversely, Switzerland's private sector provided CHF 2.3 billion in funding for R&D activities abroad, mainly in the form of mandates to companies beyond the Swiss border.

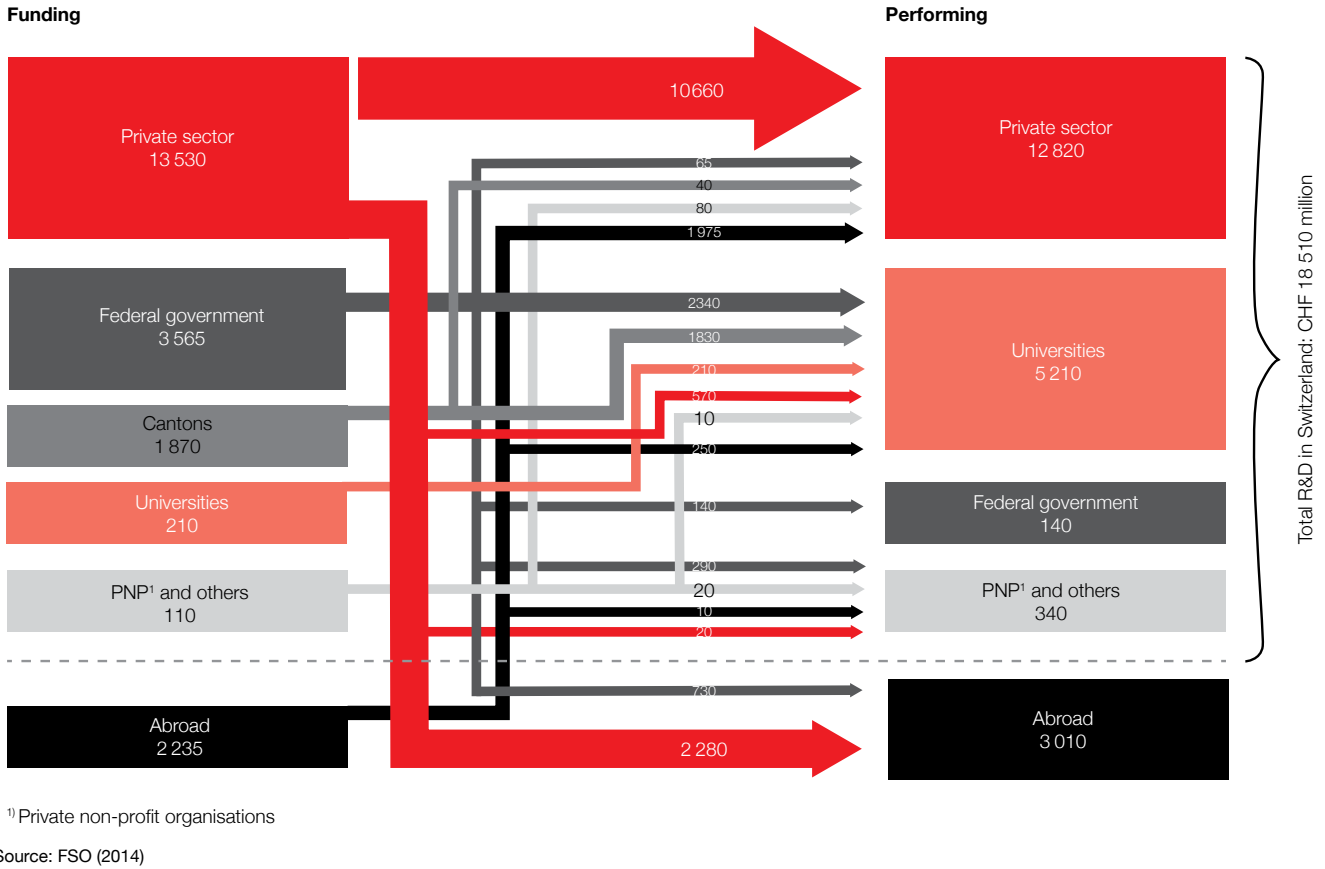
In Switzerland, other actors (private non-profit organisations, e.g. foundations, etc.) play a comparatively minor role in terms of both the funding and the conduct of research.

## 2.2 Research and Innovation Activities in the Private Sector

As mentioned above, the bulk of research and innovation in Switzerland is carried out by companies in the private sector. In 2012, companies in Switzerland performed R&D amounting to CHF 12.8 billion. This represents 2.2% of GDP.

34% of all private sector spending was channelled into pharmaceutical and chemical R&D.

Figure A 2.3: Funding and performing of R&D in Switzerland by sector, in CHF million, 2012 (excluding affiliate of Swiss companies abroad)



### The main hallmarks of how research and innovation is performed in the Swiss private sector are:

- A few large corporations in the pharmaceutical, chemical, machinery and food industries account for the majority of research and innovation efforts. Measured in terms of R&D expenditure, Hoffmann-La Roche (EUR 7 billion) and Novartis (EUR 6.9 billion) rank among the world's top ten corporate R&D players.
- That being said, R&D collaboration between SMEs and large corporations is also significant. SMEs supply the large corporations with highly specialised components, which in turn allows the SMEs to integrate their R&D activities into these corporations' value chains and reach niche markets.
- Companies in technology-intensive sectors such as ICT are primarily interested in applied R&D and less in basic research.
- SMEs play a significant part. To a greater extent than in other European countries, their development input makes them a key factor behind Switzerland's innovation output.
- Its broad mix of differently sized companies sets Switzerland apart from many other countries and is a particular boon in terms of innovation achievements.

### International Aspects of R&D Activities in the Private Sector

The private companies invested heavily in R&D tend to be international players. This is clearly reflected in research expenditure of the top ten member companies of science industries (Figure A 2.4).

Swiss controlled affiliates abroad performed R&D costing CHF 15 billion in 2012. This is higher than the amount spent by the private sector on R&D in Switzerland. While absolute R&D expenditure of Swiss controlled affiliates abroad increased by a significant 64.2% from 2004 to 2008 (partly due to the acquisition of research-intensive firms), it fell by 4.6% in the period from 2008 to 2012, but is still higher than R&D expenditure in Switzerland.<sup>2</sup>

Compared with earlier years (2004: CHF 9.6 billion) and given the increase in cross-border R&D mandates, Switzerland has witnessed far more R&D sharing with other countries and, as a consequence, much greater internationalisation on the part of Swiss R&D groups. 78% of mandates were awarded abroad and 22% in Switzerland, predominantly to other companies and only in small part to universities. Examples of research-intensive Swiss groups with a strong international focus include Hoffmann-La Roche, Novartis and Syngenta as well as ABB and Nestlé.



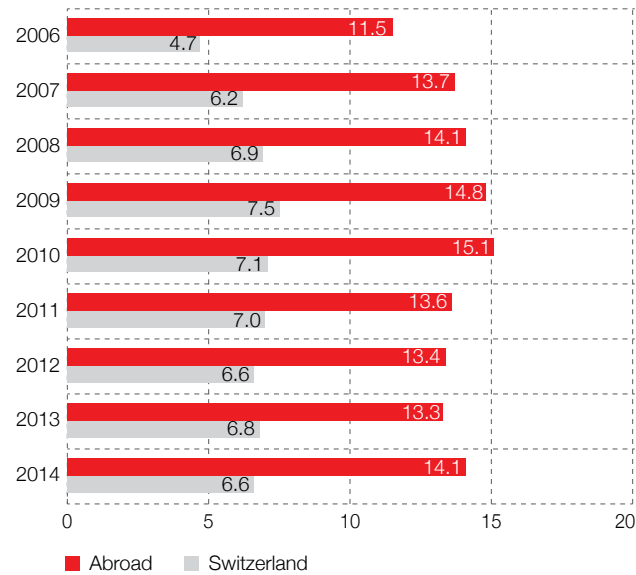
R&D personnel also attest to a high degree of internationalisation: 20,100 foreign nationals made up close on 40% of the total R&D personnel in the Swiss private sector in 2012. The percentage was 47% in the highly research-intensive chemical and pharmaceutical industries, contrasting with only 21% in the food sector.

## 2.3 New Businesses

One way to bring knowledge and new technologies to the market is to establish companies that are seeking to garner success with innovative business models that are frequently based on new technologies. Their economic significance lies less in the number of newly created jobs than in the business momentum that they generate. New businesses can be freely created on the market, formed via spin-offs from research institutes (mainly universities) or through management buyouts, where management purchases all or some of the company's assets and operations from the previous owners.

Switzerland numbers some 578,000 companies (2013). Each year around 12,000 new companies are founded,

Figure A 2.4: Research expenditure of the top ten member companies of scienceindustries in Switzerland and abroad, in CHF billion



Source: scienceindustries  
(2015; Business Association Chemistry Pharma Biotech)

<sup>2</sup> When interpreting expenditure on R&D performed abroad, the strong appreciation of the Swiss franc between 2008 and 2012 (in particular against the euro and the US dollar) must be factored in. Since R&D performed abroad was stated in Swiss francs by respondents, the figures are impacted by exchange rate fluctuations that are not quantifiable but may still influence the result.

more than 80% of which are in the tertiary sector. However, half of these companies do not survive longer than five years.

Between 35 and 45 spin-offs and start-ups emerge from the ETH Domain annually, chiefly in the high-tech sector. Their survival rate is well above average. Under its CTI Start-up Programme, CTI accepts between 65 and 75 start-ups for coaching each year and issues just under 30 labels.

Despite Switzerland's dynamic venture capital market, numerous founders encounter funding problems in the early stage. This is because venture capital companies and other investors tend to shy away from the high risks and uncertainties associated with this particular phase. To what extent Switzerland faces a lack of venture capital is a matter of contention.

In the medium term, politicians can best serve entrepreneurs by promoting favourable business conditions, i.e. lean procedures for the creation of new businesses, innovation-friendly company and bankruptcy laws, an attractive tax system as well as clear and simple legislation for the protection of intellectual property and licences. With these conditions in place, Switzerland was placed 20th in the World Bank's ease of doing business rankings for 2014 (behind e.g. Germany at rank 14). Providing fertile ground for future innovations and nurturing a greater awareness of entrepreneurial activities, Switzerland's well-organised and well-funded education and research system provides advantageous conditions for the creation of new businesses.

### Venture Capitalists: Examples

While venture capital commitments are low overall in the banking sector, there are individual banks that support newly created businesses. Aside from the cantonal banks traditionally operating in this area, Credit Suisse, for instance, provided venture capital to the tune of CHF 100 million in 2010, funding the Swiss Venture Club (SVC) via a long-term strategic partnership. The Venture Incubator (VI) also supports promising start-ups with capital, consulting and networks. Established in 2001 by McKinsey & Company and ETH Zurich, VI manages a CHF 101 million investment fund. Attractive start-ups also arouse the interest of international venture capital investors operating in Switzerland. Furthermore, in 2014, Swiss parliament approved the Graber motion (13.4184), which requires the Federal Council to examine the establishment of a private sector future fund using pension fund assets, the objective being to improve venture capital funding for young entrepreneurs. The question of whether and how a private future fund can be set up under existing structures is being discussed in a working group made up of federal representatives. The working group is engaged in extensive idea sharing with pension funds and representatives of the venture capital industry.

Photo: ESA



### Excellence in Space Science

As one of the founding members of the European Space Agency (ESA), Switzerland has co-shaped the European space industry from early stage on. Swiss engineering and technology has ever since been a vital part of successful space projects and they continue to contribute to the success of future ESA missions.





## World-leading Universities

Swiss universities are world-class education and research institutions embedded in a competitive and dynamic environment. Moreover, several are ranked among the top 100 universities in the world such as the University of Zurich with its renowned library, planned by the star architect Santiago Calatrava.

## 2.4 Activities at Universities and the Role of Vocational and Professional Education and Training

### Domain of the Federal Institutes of Technology and Cantonal Universities

The domain of the Federal Institutes of Technology (ETH/EPLF Domain) is one of the key engines of the technological and scientific implementation of knowledge in Switzerland. Its activities mainly embrace areas of strategic importance to Switzerland's competitiveness, e.g. the life sciences, nanotechnology, and ICT. ETH Zurich and EPFL jointly numbered almost 28,000 students in 2014, including some 6,000 doctoral students. These are the only two higher education institutions outside the UAS sector to offer engineering syllabuses.

A total of 116,000 students were enrolled at the ten cantonal universities in 2014, almost 18,000 of whom were doctoral students. Albeit in different constellations, the cantonal universities have faculties and institutes in the areas of law and social sciences, mathematics and natural sciences, the humanities, economics, and medicine. In common with the ETH Domain, basic research is among the core activities of the cantonal universities, forming the foundation for first-rate university teaching in addition to successes in terms of knowledge and technology transfer.

By international comparison, Switzerland's academic system produces outstanding results. The majority of students in Switzerland are enrolled at an ETH institute or cantonal university among the world's top 200 in various international rankings. Measured according to the impact of a country's scientific publications in various fields of research, in the period 2007–2011, Switzerland ranked 1st in the three areas "technology, engineering and information sciences", "physics, chemistry and geosciences" and "agriculture, biology and environmental sciences", 3rd in the life sciences, 4th in the social and behavioural sciences, and 7th in clinical medicine.

### Universities of Applied Sciences

The seven public UAS had a total student count of 70,000 in 2014 (excluding students at the universities of teacher education). The UAS put together the initial education and continuing education and training programmes to supply the labour market with a suitably qualified workforce. Approximately two thirds of engineers in the Swiss business sector are UAS-educated.

The UAS are also heavily engaged in applied R&D, which they closely align with the needs of the business sector, society and the arts, and in so doing play a vital role in translating knowledge into marketable innovations. In particular, the UAS work hand in hand with SMEs, as well as public and semi-public institutions in the areas of health-care, welfare and the arts. With their strong regional presence and reach, the UAS are a productive and indispensable partner to Switzerland's innovation-driven business sector with its strong SME base.

The UTE trained a total of 19,500 teachers in 2014. UTE address questions of organisational and teaching methodology, subject didactics, the psychology of learning, the education system and its actors. Their research and evaluation findings create the basis for the ongoing evolution of lessons and schools, teaching professions, and evidence-based educational policy decisions. The pedagogical and subject teaching research they conduct fosters new methods and theoretical standards in teaching.



## Vocational and Professional Education and Training

University graduates are not the sole key drivers of corporate Switzerland's innovative and competitive leverage. Skilled workers who have completed a vocational apprenticeship, some of whom have gone on to earn tertiary professional qualifications, are also vital. They are instrumental in making innovations marketable and implementing them.

In Switzerland, vocational and professional education and training takes place at the upper secondary (vocational education and training) and tertiary (professional education) levels. It provides an equally valuable adjunct to general education and the more academic university curricula.

The fact that vocational and professional education and training is fully integrated into the entire education system offers a high level of flexibility. The principle of no dead-end qualifications applies both within and between the vocational and professional education and training sectors and the general or university education sectors.

Vocational and professional education and training in Switzerland is very much geared to the labour market. Organisations in the working world define and update the content of professional initial education and continuing education and training programmes to ensure that they meet the actual needs of the labour market.

Approximately two thirds of young people begin their working careers with vocational education and training (upper secondary level). Dual training at the workplace (practice) and vocational school (theory) is the most common type of vocational education and training in Switzerland. Companies play a central role in aligning training to the labour market by integrating trainees into real work processes. Trainees are already productive during their apprenticeships. Training also pays dividends for companies, particularly in terms of securing the next generation of skilled workers and, in many cases, it also pays off financially. A 2009 survey showed that gross training costs amounted to CHF 5.3 billion as against productive output of CHF 5.8 billion, equating to a net benefit of CHF 0.5 billion for companies.

Following on from vocational education and training, professional education at tertiary level allows professionals holding a Federal Vocational Education and Training Diploma or equivalent to specialise and acquire advanced qualifications, including management diplomas.

With around 64,900 trainees successfully completing basic training each year and some 25,500 skilled professionals earning higher vocational qualifications, the business and administration sectors can draw on a pool of proven skilled workers with recognised federal qualifications. Vocational and professional education and training is an essential part of the process of producing well-qualified specialists equipped to work along the entire value chain, a factor that is critical to Switzerland's research and innovation capabilities.



Vocational education and training (VET) is for many students the first step in their career. Around 70% of all secondary school graduates decide to start a VET. An apprenticeship combines excellent school education and on-the-job training. During one or two days per week, depending on the profession, the students go to school to learn job-related background knowledge. The rest of the week, the students work in a company and get valuable on-the-job training.



## Innovative Mind-set at Swiss Universities

Swiss students are constantly pushing the frontiers in research. A team of Bachelor and Master students from the ETH Zurich are building a Hyperloop prototype, called Swissloop, for an international Hyperloop pod competition besides their studies. This project is a good example to show that innovation in Switzerland already starts on the education level.



## 2.5 Federal Government Research

Professional administrative work and the systematic handling of complex policy situations demand well-founded scientific knowledge. This knowledge is acquired in part through Federal Government Research, which the administrative offices either conduct themselves or commission universities or private companies to carry out.

The federal government operates its own research institutes and so has the R&D resources and the capabilities to conduct R&D. Among the federal offices that carry out R&D are Agroscope, a research station attached to the Federal Office for Agriculture, and MeteoSwiss, the national weather and climate services provider. On the other hand, under the mantle of Federal Government Research, the federal government also awards outside R&D contracts and grants as a means of promoting research (see Section 3.1.2).

## 2.6 Interaction Between Research and Innovation Actors

Collaboration between companies and between companies and universities is becoming increasingly important for innovation success. The capabilities and services of partners can be strategically deployed to actively enhance an innovator's own innovation potential.

Interaction of this kind is witnessed to varying degrees in Switzerland. Switzerland is one of the five most innovative economies in Europe (in order of ranking: Switzerland, Sweden, Denmark, Finland, Germany). While in terms of public-private co-publications Switzerland performs well compared with the countries named, measured by collaboration among innovative SMEs it is well below the mean for these same countries. The significance of this last indicator is put into perspective by the fact that Swiss SMEs score well on an international comparison when it comes to the launch of innovative products or processes.

Knowledge and technology transfer (KTT) is the exchange, provision and transmission of information, competencies and R&D results between universities and research institutes on the one hand and societal institutions (such as companies and public administration) on the other. The objective is to initiate and reinforce innovation processes, with partners focusing on the commercial exploitation of available and/or jointly created knowledge.

The legal framework expressly provides that services and KTT are among the tasks of ETH Zurich, EPFL, cantonal universities and UAS. Since KTT traditionally centres on research and teaching, the main proponents are well educated graduates working in the corporate sector

(“brain transfer”). Over the past ten years, KTT has been continually enhanced and increasingly institutionalised and formalised.

With Switzerland a member of the European Space Agency (ESA), the federal government is pursuing a space technology policy that likewise explicitly requires KTT and promotes it via the ESA's technology development programmes. The federal government also uses ESA channels to engage in KTT from the ESA's institutional programmes to the commercial market. Supplementary national measures are also being implemented to promote KTT in the space technology sector.

Also of significance is knowledge transfer from the domains of healthcare, welfare, the arts, the humanities and the social sciences in the form of consulting, situation appraisals, analyses and potential solutions offering innovative prospects for areas of society.

### Technology Transfer Offices

The technology transfer or KTT offices of research institutes and education establishments source experts in the field within and outside their institutions for R&D projects, they identify and evaluate research results with commercial potential, define an exploitation strategy in consultation with the researchers and implement it jointly with the latter and companies in the business sector.

**There are three different types of institutional KTT office in Switzerland:**

- The KTT office serves as a central administrative or specialist unit that is fully integrated into the university. This is the form chosen by the majority of such universities, e.g. “ETH transfer” at ETH Zurich.
- The KTT office is integrated into the university, but its activities are carried out mainly on a decentralised basis in the various departments and in connection with outside KTT mandates. This type of organisational model is seen at several UAS.
- KTT is funded under a collaborative venture between several universities. A company, co-owned by them, is mandated to serve as external KTT office to oversee and drive transfer processes. Unitectra AG, set up jointly by the Universities of Zurich, Berne and Basel, is an example of this type of solution.

The Swiss Technology Transfer Association (swiTT) is the association of technology transfer professionals who are primarily engaged in collaborations between public and private research institutes, hospitals and other non-profit research organisations. The association facilitates KTT networking between research institutes and the business sector. Members and other KTT actors in the academic and business sectors benefit from professional support and development accompanied by a broad range of services. swiTT keeps a dialogue going with research institutes, businesses and administrative agencies to help secure optimum conditions for KTT. The association maintains the only comprehensive list in Switzerland of tech-

nologies offered by universities to the private sector.

### Centres of Technological Excellence and Public-Private Partnerships

Centres of technological excellence according to Art. 15c RIPA also have a technology transfer mandate and an associated strategy. As a rule, they are legally independent non-university research institutes of national significance that work together with universities and the private sector. Examples include the Centre suisse d'électronique et de microtechnique (CSEM), Campus Biotech Geneva and inspire AG, which is active in the area of mechatronic production systems and manufacturing technology. Positioned at the interface between (university) research and practical business application, these centres make a major contribution to KTT.

Centres of technological excellence are financed according to the matching funds principle: The federal government can furnish them with basic funding if cantons, other public bodies, universities or private entities also make a substantial contribution. The law provides for collaboration on a non-commercial basis. Accordingly, revenues from patents or the assignment of rights of use to third parties must be re-invested.

In general, the KTT potential offered by public-private partnerships between universities and the private sector is being increasingly tapped into in Switzerland. The European Space Agency ESA is implementing more and more programmes in the form of public-private partnerships in which Swiss companies are actively participating as consortium members. One such initiative is ESA BIC Switzerland, put in place to develop a business incubation and acceleration centre for start-ups which are active in space technologies or transfer and apply them to non-space technology areas. This model, which is co-financed subsidiarily through the ESA membership fees paid by the federal government, envisages the gradual phasing out of funding, namely by using profits earned on successful start-ups to re-finance new start-up ventures. This spreads both the risk and the success between public and private partners.

### Swiss Innovation Park

Swiss Parliament defined the idea of a Swiss Innovation Park as a federally harmonised national network with various locations and enshrined it in the RIPA: “The innovation park serves a greater national interest, competitiveness, resource efficiency and sustainable development”.

The Swiss Innovation Park is a revenue-generating project to secure private R&D investments and the long-term sustainable strengthening and dynamisation of Switzerland in the face of international locational competition. The underlying aims are to make networking between the science and business communities even better, to create optimum innovation-friendly conditions for local companies and researchers, and to encourage new actors to locate here. Internationally recognised, highly productive companies with a strong and busy research and innovation track record need to be won over for the project.

The initial configuration of the park as at 1 January 2016 consists of two hub locations in the vicinity of the two Federal Institutes of Technology and three network locations in the canton of Aargau, in Biel/Bienne and in north-western Switzerland. The concept and implementation of the Swiss Innovation Park are intended to complement and strengthen the existing tried and proven innovation system and the various regional subsystems. The design and organisation are flexible enough to allow a dynamic development of the Innovation Park. In accordance with the provisions of the RIPA, the Swiss Innovation Park Foundation was set up in spring 2015 by private individuals as the park's umbrella organisation.

The local site sponsors (cantons), the private sector and the universities involved will be responsible for the operation of the Swiss Innovation Park.



## Paul Scherrer Institute

The Paul Scherrer Institute PSI is the largest research institute for natural and engineering sciences in Switzerland, conducting cutting-edge research in three main fields: matter and materials, energy and environment and human health. PSI develops, builds and operates complex large research facilities. Every year, more than 2500 scientists from Switzerland and around the world come to PSI to use their unique facilities to carry out experiments that are not possible anywhere else. By conducting fundamental and applied research, the Paul Scherrer Institute (PSI) works on long-term solutions for major challenges facing society, industry and science.



# 3 Research and Innovation Promotion: Instruments and Measure

## 3.1 Public Sector and Foundations in Switzerland

### 3.1.1 Federal Promotion Institutions

The Swiss National Science Foundation (SNSF) is the federal institution for the promotion of research. CTI is the federal agency responsible for the promotion of science-based innovation. Serving in an advisory role, the Swiss Academies of Arts and Sciences seek to foster a dialogue between the science community and society.

The small number of promotion institutions in Switzerland contrasts with other European countries such as France, Germany and the UK, which have a great many more promotion agencies. The fact that Switzerland's institutions are financed entirely with federal funds is something else that sets the Swiss model apart from many of its foreign counterparts. For instance, the Deutsche Forschungsgemeinschaft (DFG), Germany's equivalent to the SNSF, is co-funded by the German states.

### Swiss National Science Foundation

The SNSF is Switzerland's foremost institution for the promotion of scientific research and young scientists. All scientific disciplines from history to medicine to engineering have access to SNSF grants.

#### The SNSF's strategic goals are derived from its Statutes and mission statement:

- Support high-quality research as well as researchers in their quest for excellence.
- Bring research funding closer into line with the researchers' needs.
- Support the spread of knowledge in society, the economy and politics and demonstrate the value of research.

To ensure its independence, the SNSF was established as a private foundation in 1952. Based on a multi-year programme with research priorities, a service level agreement between the SNSF and the SERI stipulates the binding goals and performance indicators for the relevant four-year period. Both parties regularly monitor goal attainment.

The SNSF meets the multi-faceted needs of researchers. Its promotion activities are directed at two research categories, as reflected in its multi-year programmes. The SNSF primarily promotes pure basic research (research contributing to a general gain in knowledge without any

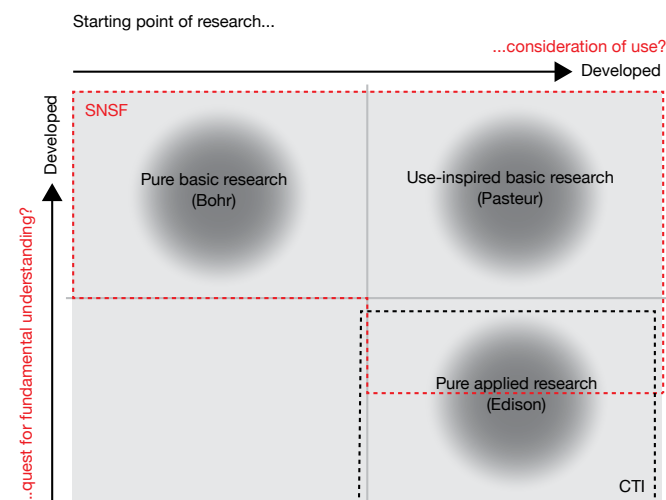
specific application or exploitation) and not applied research aimed at the direct exploitation of results for commercial purposes. The broader impact of the category "use-inspired basic research" is also factored in as an evaluation criterion and outside experts working in the field are called in as reviewers.

The SNSF follows Pasteur's quadrant model, which draws a distinction between research aimed at bringing about a general gain in knowledge and research which serves a specific application (Figure A 3.1):

- Research designed to produce a general gain in knowledge without any specific application or exploitation is referred to as "pure basic research".
- If the focus is on a specific application, we refer to "pure applied research". It contributes to finding practical solutions to problems and engenders innovations.
- Research combining both components is labelled "use-inspired basic research".

The SNSF has a broad range of research promotion instruments at its disposal. Funding is on a competitive basis.

Figure A 3.1: Areas promoted by the SNSF and the CTI, broken down according to the model "Pasteur's Quadrant – Basic Science and Technological Innovation"



Source: SNSF (2010), edited by SERI

The main instrument is project funding, for which the SNSF uses approximately half of approved grants under its service level agreement with the federal government. The SNSF creates the necessary leeway for innovative ideas by allowing researchers receiving project funding to freely choose the topic and scope of their research.

In the case of other funding vehicles, the general thematic, conceptional and organisational parameters are prescribed. This applies in particular to the National Research Programmes (NRP) and the National Centres of Competence in Research (NCCR):

- NRP generate scientific knowledge aimed at solving Switzerland's most pressing problems. Limited on average to a period of five years, they are solution-driven and therefore qualify as applied research. KTT is a prime objective. The topics are specified by the Federal Council on the basis of calls for proposals open to all scientific disciplines and the subsequent evaluation of the proposals received.
- NCCR, on the other hand, support the long-term establishment of centres of excellence and networks in research areas of key strategic importance for the future of Switzerland's scientific community, business sector and society, e.g. the nano sciences, life sciences, robotics, climate and democracy. With a longer timeframe of approximately ten years, NCCR are designed to help create a powerful research structure. The funding framework for NCCR is decided by Parliament. In addition to the federal contribution allocated, it is imperative that NCCR receive co-funding from universities and third parties. NCCR topics are likewise stipulated by the Federal Council following an evaluation process and referred to the SNSF for execution.

Other SNSF programmes currently ongoing are focused on collaborative projects, clinical research and international cooperation.

The training of young scientists is a core responsibility of the SNSF. Each year it supports some 4,500 doctoral students and 2,500 postdocs through projects and programmes. The SNSF's career promotion efforts are aimed at supporting young talents specifically from the dissertation stage up to an assistant professorship – e.g. through fellowships abroad or SNSF professorships. Other new career assistance measures designed to improve conditions for the rising generation of scientists in Switzerland include support grants for young SNSF-funded researchers with families, or individual and flexible supplementary career development subsidies in the form of gender equality grants for young women researchers being funded by the SNSF.

At international level, the SNSF also provides funding to facilitate cross-border collaborations entered into by research groups and institutions. The SNSF pursues two main objectives here: In the context of collaborations with industrial and emerging countries, and as far as the instruments at its disposal allow, the SNSF aims to support existing partnerships, smooth the way for new initiatives and help Swiss researchers gain access to international research programmes. In respect of developing and trans-

sitioning nations such as the former Eastern bloc states, the goal is to secure access for Swiss researchers to local research groups and help raise scientific capabilities in these countries to international standard.

## Commission for Technology and Innovation (CTI)

CTI is the federal agency for the promotion of innovation. It encourages science-based innovation and the development of new products, procedures, processes and services for the business sector and society through research (predominantly applied research) and the exploitation of its results.

CTI has the status of a federal commission with decision-making powers. It is affiliated to the EAER. It forms part of the decentralised Federal Administration and has the autonomy to act at its own discretion. Acting on behalf of the EAER, SERI agrees multi-year funding programmes with CTI. SERI also assumes any sovereign tasks in this dossier, including the negotiation of international agreements in the area of innovation promotion, drafting principles of federal innovation policy and evaluating CTI and its funding activities. Work is currently underway on an organisational reform of CTI that is scheduled to enter into force in 2018. In November 2015, Federal Council referred its Dispatch on the Federal Act on the Swiss Innovation Promotion Agency (Innosuisse Act) to Parliament. The bill is intended to put in place the legal basis to transform CTI into a public-law entity.

The core task of CTI is to provide project funding which, as a general rule, is available to all disciplines. Approval of an application for project funding hinges mainly on the innovative content and the prospects for effective implementation of the research findings to the benefit of the business sector and society. A further condition is that the project is unlikely to be realised without federal project funding. CTI project funding is also contingent on the formation of an alliance between a higher education institution or non-commercial research establishment and one or more private or public sector partners willing to assume responsibility for exploitation (implementation partners). This latter stipulation ensures that CTI projects directly drive KTT. Funds are allocated exclusively to public sector partners and are used mainly to cover personnel expenditure. Implementation partners are required to co-fund at least half of the project with their own resources plus, as a rule, a cash contribution of minimum 10%. Exceptions are possible. Research funding in Switzerland in general and from the CTI in particular is, in principle, not paid directly to companies.



In addition to its core role as project funder, the CTI also performs the following innovation promotion tasks:

- The CTI provides coaching and continuing education and training opportunities in order to promote science-based entrepreneurship in Switzerland and support the founding and establishment of science-based companies.<sup>3</sup>
- SMEs can apply for a CTI innovation cheque worth CHF 7,500 to help fund minor preliminary project studies.
- Through its participation in international bodies and programmes, the CTI also engages in the conception, planning and implementation of R&D promotion activities and the evaluation of international projects, unless another agency is responsible under international treaties. During the 2013–2016 funding period, the CTI is deploying three instruments designed to promote KTT between companies and universities and sustainably support Swiss innovative activities in the Swiss corporate sector:
  - National thematic networks (NTN): NTN are nationwide networks specialising in a specific innovative topic. They put companies in touch with researchers at universities, provide access to infrastructures and promote collaborations with suitable research institutes.
  - (Regional) innovation mentors: CTI innovation mentors with a professional background in research and business inform SMEs of the innovation funding opportunities open to them in Switzerland and provide help in drawing up applications for project funding.
  - Information and networking via thematic platforms: KTT platforms bring representatives of the business and science communities together and connect innovation mentors and national thematic networks both physically and interactively.

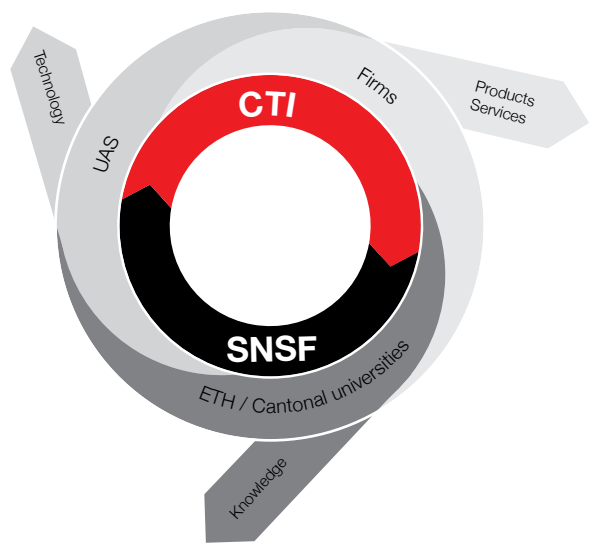
Collaboration between SNSF and CTI

Under their legal mandates, the SNSF promotes scientific research and the CTI science-based innovation.

The lines between the two are fluid. At the SNSF, promotion centres on gaining scientific knowledge. The focus of promotion at the CTI is on the development of new products, procedures, processes and services. Whereas the participation of a paying implementation partner as a condition of funding clearly sets the CTI apart from the SNSF, there is nonetheless some overlap in terms of promotion. In such cases the CTI and SNSF coordinate their strategies, resulting in numerous fields and forms of collaboration, e.g. under Switzerland’s Coordinated Energy Research action plan from 2013 to 2016. A further goal of collaboration is to close research funding gaps between pure basic research to gain knowledge (financed by the SNSF) and directly applied research for the purpose of implementation and marketing (frequently financed by the CTI).

While the SNSF and the CTI essentially have different and complementary task profiles, both organisations welcome funding applications from all specialist areas and disciplines.

Figure A 3.2: Partnership in the innovation process



Source: SNSF

Neither the SNSF nor the CTI applies quotas in favour of universities, individual research institutes or regions. The decisive criterion is not the provenance (e.g. cantonal university, ETH or UAS), but the content, primary objective and quality of the projects. However, practice shows that the majority of funding applications for projects from universities are submitted to the SNSF, whereas most UAS submissions go to the CTI.

Swiss Academies of Arts and Sciences

The Swiss Academies of Arts and Sciences receive approximately CHF 30 million in funding annually from the federal government and also have a service level agreement with the latter. The academies are committed to fostering a dialogue between the science community and society at large and they advise policymakers and civil society actors on socially relevant science-based issues. They represent the sciences across institutions and disciplines. Established in the scientific community, the academies have access to excellence and expertise, which they draw on to address overarching questions of concern for that community (scientific culture, infrastructure planning, etc.), to inject specialist know-how into key political discussions, to engender a fundamental understanding of science on the part of society and to promote debate with its members.

The Swiss Academies of Arts and Sciences comprise the Swiss Academy of Sciences (SCNAT), the Swiss Academy of Humanities and Social Sciences (SAHS), the Swiss Academy of Medical Sciences (SAMS) and the Swiss Academy of Engineering Sciences (SATW). Affiliate organisations include the Centre for Technology Assessment (TA-SWISS), the foundation Science et Cité (a low-threshold interface between scientists and the public), as well as other scientific networks.

<sup>3</sup> The CTI Start-up initiative supports start-ups with coaching and network-based platforms. CTI Entrepreneurship is a parallel initiative designed to foster entrepreneurship in knowledge-intensive and technology-based areas.

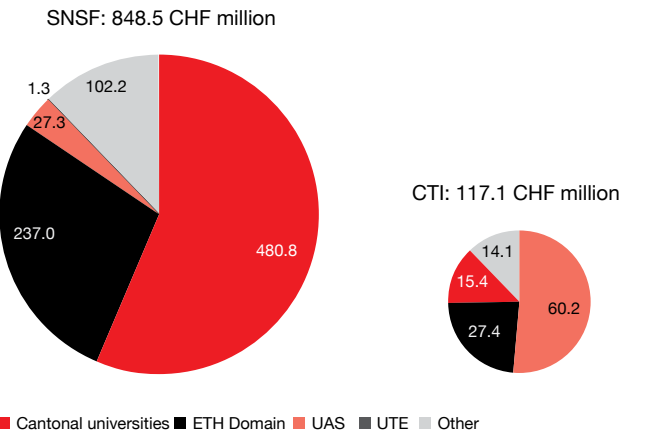
3.1.2 Federal Government Research

Federal Government Research is initiated by the federal government when it needs the relevant findings to be able to fulfil its tasks (see Section 2.5). The federal government has its own research facilities for this purpose, but it also gives funding to outside parties and conducts its own research programmes in collaboration with university research institutes and research and innovation promotion agencies.

The federal government also awards research contracts (contract research). These contracts are usually for expert assessments and opinions or for follow-up studies to review the efficacy of ratified political measures. Federal Government Research also provides the federal government with a conduit to engage in research promotion. It can award contracts for practically all types of scientific research, from basic or applied research to near-market development, such as the engineering of pilot and demonstration facilities.

Over 30 federal offices are involved in Federal Government Research, which, in the interests of optimum coordination, has been divided by the Federal Council into eleven policy areas. Normally covering a four-year period, a research concept is drawn up by the lead government office, aided by outside scientific consultants, for each of these policy areas. SERI is responsible for coordination. In 2014, the federal government invested around CHF 286 million in Federal Government Research.

Figure A 3.3: SNSF and CTI funding commitments, by institution, 2014<sup>4</sup>



Source: SNSF and CTI

<sup>4</sup> SNSF figures relate to grants awarded in the funding categories projects, careers, programmes, infrastructures and science communication. In addition to the figures shown, in 2014 the SNSF set up Temporary Backup Schemes totalling CHF 92 million to make up for lost EU funding during Switzerland’s temporary exclusion from the EU Framework Programmes for Research (following the adoption of the “Stop mass immigration” initiative on 9 February 2014). The CTI figures relate to commitments for approved projects as part of regular R&D project funding.

3.1.3 Regional Innovation Systems under the Federal Government’s New Regional Policy

Regions are playing an increasingly significant role in innovation promotion on account of inter-regional disparities in competitiveness and innovative capabilities within a country. An international cross-comparison shows that Switzerland has for several years been ranking high in various innovation ratings, while the share of innovating companies differs according to type of region.

Since coming into force in 2008, the federal government’s New Regional Policy – under SECO’s stewardship – has been directed at making the regions more competitive by promoting regional innovation and entrepreneurial momentum.

In order to take into consideration the different needs of the broad SME base in the regions and be able to lock into the available innovation potential, the New Regional Policy (in keeping with the OECD recommendation in its Territorial Review of Switzerland 2011) takes a holistic view of innovation, which embraces scientific as well as knowledge-based innovations.

Coordinated with the CTI, the promotion of innovation in the regions is a priority of the federal government’s next regional policy programme (2016–2023). The objective is to increase innovation dynamism in the regions by making regional innovation systems (RIS) stronger. RIS need to have critical mass if they are to deliver an effective and efficient services portfolio and at the same time be sufficiently close to the SMEs. From the federal government’s perspective, Switzerland has the potential to accommodate six to seven intercantonal and partly cross-border RIS that are also coordinated with one another via their interfaces. In the area of innovation promotion, the New Regional Policy provides incentives to ensure that the cantons funding an RIS improve coordination of the underlying promotion instruments, align them with a common innovation strategy and manage the RIS jointly. Particular focus is to be placed on improving the support options available to SMEs. Once all of this is achieved, the cantons can use regional policy to support the region’s SMEs through customised programmes designed to help them realise their innovation projects.

A “no wrong door” approach should be taken towards companies. Regardless of which actor (e.g. cluster, business and economic development or technology transfer office) that they contact within an RIS, they should be referred to the appropriate network partner or partners to look after their specific needs.

Since regional policy is shared between the federal government and the cantons, the latter – in accordance with the principle of subsidiarity – are given considerable rein in the concrete formulation of their RIS programmes and the choice of services they offer. Services portfolios will therefore differ from RIS to RIS (e.g. clusters, innovation coaching, events, sector-wide coordination projects, skilled worker initiatives).



The vision is that the overall impact of the federal government's national innovation promotion efforts will be strengthened by tying in the regions and their complementary measures to foster regional innovation.

### 3.1.4 Cantonal R&D and Innovation Promotion

The large majority of cantons engage in innovation and business promotion, partly supported by regional policy measures. The services portfolio may include start-up support or the promotion of regional networks and clusters in close contact with companies and in some cases specific coaching. The cantons operate through business and economic development offices of their own or in association with other cantons. These offices inform companies about the locational advantages of their canton, they maintain contact with investors, make location proposals, organise support for investors, and provide local customer care. Various cantons offer tax breaks to promote business. The cantons also use their education and training establishments as vehicles to promote regional development.

As active promoters of innovation, cantonal banks as well as some regional banks are also part of the innovation system. They offer special start-up funding and equity financing. A number of cantonal banks offer support in direct partnership with, say, a technopark or business angels. For instance, at the instigation of Technopark Lucerne, Luzerner Kantonalbank launched the venture capital firm Wachstumskapital AG, an innovative financing instrument for start-ups in the region. Members of the Technopark have already successfully presented several projects to the firm's investment committee. St. Galler Kantonalbank is engaged (including financially) in the STARTFELD Foundation, which provides early-stage start-up financing. Since January 2015, Berner Kantonalbank (BEKB) has offered an early-stage service on its electronic trading platform for unlisted Swiss shares. This new tool is intended primarily for trading in shares of fast-growing start-ups.

Cantonal banks are widely involved in competitions and sponsorships for particularly innovative firms. St. Galler Kantonalbank is a case in point, each year presenting an award for top entrepreneurial achievements that stand out in terms of innovative strength, sustainability and the substantial contribution they make to the location's appeal. The award goes to companies whose business activities also have implications for society at large in that they serve to enhance the region's well-being economically, ecologically and socially.

Various cantonal banks provide assistance in the form of start-up handbooks and models, e.g. "A business start-up guide" and "The ideal toolkit for entrepreneurs" from Banque Cantonale de Genève or the Berner Kantonalbank toolbox for SMEs and start-ups containing practical templates for day-to-day business.

### 3.1.5 Communal Innovation Promotion

The cities and municipalities also engage in innovation promotion. Business incubators and technoparks are fairly widespread. As a general rule - TECHNOPARK® Zurich being one example – they are privately financed, sometimes in cooperation with the public sector. Normally, a real estate firm provides a building, and an operating company selects innovative firms to use the premises and supports them with diverse services.

### 3.1.6 Foundations

Foundations also promote research and innovation. In 2013, almost 13,000 non-profit foundations enriched Switzerland's cultural, social and scientific life. Just under one fifth of them provided funding to universities.

For example, the foundation Gebert Rűf Stiftung (established in 1997) defines its purpose as promoting Switzerland as a place to live and do business. With an annual budget of around CHF 10 million, it finances projects at Swiss universities. It supports innovation by promoting new methods and selected young scientists at start-ups and elsewhere during the "valley of death" phase, a lean period between public R&D funding and initial commercial loans. The Foundation's interest is directed at ambitious initiatives from qualified project managers wishing to break new ground.

The Swiss Cancer Research Foundation funds projects from the entire spectrum of oncological research, awards grants, supports Swiss research organisations and international organisations and stages scientific congresses and workshops.

Since foundations finance a large and varied array of research and innovation projects and apply widely diverging funding criteria, they are instrumental to the diversity of research and innovation promotion.

By way of illustration, the open support provided by the Hasler Foundation complements public funding instruments in cases where they cannot be accessed, be it for formal or material reasons.

### Cantonal and Regional Innovation and Business Promotion: Examples

**Canton Berne:** The canton promotes innovation activities in individual clusters within its business sector, including ICT, precision engineering, medical technology, energy and environmental technology, as well as design and luxury goods. It passes on certain tasks to technology brokers and business incubators, in some instances under service level agreements. In the case of CTI-funded R&D projects (prototype development) conducted by Bernese SMEs and start-ups, the canton also assumes part of the business financing that the latter are required to provide.

**Canton St. Gallen:** The canton supports innovation drives by companies carrying out projects aimed at specifically furthering KTT and generating momentum for future collaborations. It also runs an innovation office, which provides data on R&D partners and technology capabilities in the canton and region, as well as supplying information on networks and promotion programmes.

**Canton Ticino:** Cantonal legislation has been in place since 1997 to promote, where possible, all industrial and service companies engaged in commercial innovations. Support may be in the form of funding or of an indirect nature (support for industrial zones, consulting and intermediation, continuing education and training, creation of new businesses). Above and beyond this, under the auspices of its regional economic policy programme, the canton of Ticino established the Agire Foundation (Agenzia per l'innovazione regionale del Cantone Ticino) together with the local UAS (Scuola universitaria professionale della Svizzera italiana, SUPSI), the university (Università della Svizzera italiana, USI), the Camera di commercio, dell'industria, dell'artigianato e dei servizi (CC-TI) and the Associazione Industrie Ticino (AITI). Agire is a platform for KTT and entrepreneurial promotion, mainly in the area of innovative technologies.

Within the framework of regional policy, the cantons in French-speaking Switzerland have been promoting a joint entrepreneurship and innovation programme since 2008. One element of this joint innovation promotion venture is platinn, an association established under private law. Its Executive Committee is composed of business promoters appointed by the six participating cantons. platinn supports start-ups and SMEs in their innovation projects to help them develop their capacity to innovate and compete. Support is provided by a network of accredited coaches. If necessary, they will bring in specialists in areas such as intellectual property, strategy or finance. platinn coordinates a network of experts and partners themselves firmly rooted in the participating cantons. Cantonal antennas have the shortest and most direct access to local companies. They make platinn's support services known to start-ups and SMEs and coordinate these with cantonal instruments and promotion strategies. Selected and mandated by the respective cantons, the cantonal antennas are Fri Up (Fribourg), Innovaud (Vaud), CimaArk (Valais), Service de l'économie (Neuchâtel), OPI (Geneva) and Creapole (Jura).



## Deep Brain Stimulation

Numerous Swiss hospitals cooperate closely with universities in cutting-edge medical research and also participate in the training and continuing education and training of medical staff. The method known as deep brain stimulation consists of a mini-invasive surgical intervention in which the patient is fitted with very fine electrodes which generate a chronic stimulation of the brain. In allowing pathological faults to be corrected and brain functions to be improved, these electrodes result in a net reduction of the symptoms of locomotor disorders such as Parkinson's disease, trembling, dystonia or psychiatric illnesses such as obsessive-compulsive disorder and depression. In Switzerland, most operations of this type are carried out at the University Hospital in Bern, and this is also where patients receive follow-up neurological care.





## 3.2 International Research and Innovation Collaboration

In 2010, the Federal Council defined its international strategy for R&D and innovation promotion and drew up long-term guidelines. The underlying intention is to consolidate Switzerland as one of the world's most competitive ERI locations and to enter into cross-border collaborations to systematically create the conditions needed to achieve this. International instruments of research and innovation promotion complement the national instruments and give Swiss actors access to key international networks.

### 3.2.1 Cooperation with the European Union

Relations between Switzerland and the European Union (EU) in the areas of education, research and innovation are, where possible, defined on the basis of bilateral agreements.

### European Union Framework Programmes for Research and Innovation

The multi-year EU Framework Programmes for Research, Technical Development and Demonstration Activities (Framework Programmes for Research, FPs) have been the EU's chief instrument for the promotion of R&D and innovation since 1984. FP funding is awarded competitively on the basis of Europe-wide calls for proposals.

The Research Accord of 2004 concluded subsequent to the Bilateral Agreements I afforded Switzerland "associated country" status, enabling it to participate widely in the 6th European Framework Programmes (Research and Euratom). The Accord was renewed for the 7th programme generation (2007–2013).

The follow-up programme "Horizon 2020 – The EU Framework Programme for Research and Innovation" from 2014 to 2020 has a budget of EUR 80 billion for research and innovation. The world's largest instrument for the promotion of research and innovation, it covers a broad spectrum of thematic areas (e.g. medicine, information technologies, the humanities and social sciences, the environment, nutrition, transport, aerospace). "Horizon 2020" is targeted at individual researchers, academic consortiums, companies and collaborations between the science and business communities. The main focus is on enhancing scientific excellence, on strengthening the European business sector's innovative capacity (including an increase in venture funding and innovation output within the SME segment) and on the contribution that research and innovation outcomes can make towards solving the central challenges facing society. As a cross-sectoral undertaking, Horizon 2020 also provides support for the European Institute of Innovation and Technology (EIT) with the aim of reinforcing collaboration between Europe's most productive institutes, universities and industrial research centres. Falling

within the ambit of Horizon 2020, the Marie Skłodowska-Curie actions continue to provide travel grants for researchers.

Aimed at peaceful uses of nuclear power, the European Atomic Energy Community's Framework Programme for Research and Training Activities in the Nuclear Field (Euratom Programme) will run parallel and complementarily to Horizon 2020. Under a collaboration agreement, Switzerland (predominantly EPFL, the Paul Scherrer Institute and the University of Basel) has been participating in the Euratom Programme in the area of controlled nuclear fusion and plasma physics since 1978. Switzerland has also been working concurrently on the major International Thermonuclear Experimental Reactor (ITER) project in Southern France. Horizon 2020, the Euratom Programme and the ITER project together make up the so-called "Horizon 2020 package".

Participating in the Horizon 2020 package brings the Swiss research community many benefits. Researchers from Switzerland can work on international projects with the world's research elite since FPs are also open to researchers from e.g. the USA and China. The proportion of successful project applications from Switzerland has been exceptionally high, including for generous ERC grants awarded by the European Research Council which was introduced at the same time as FP7. As a partially associated country paying a GDP-based flat-rate amount into the overall budget for all FPs, Switzerland derives a net financial benefit since the competitively won EU grants have to date been higher than the flat-rate membership fee remitted by the federal government. It is, however, more difficult to assess the numerous positive research-based and network-specific scientific and technological consequences of Switzerland's participation in the FPs or the impact of the ensuing innovations on the Swiss economy. Switzerland's particular strengths within the FPs lie in the future-proof areas of ICT, healthcare and nanotechnology.

The Euresearch information network is mandated by SERI to provide researchers from public institutions and the private sector with information and advice on participating in the European Union Research Framework Programmes. Euresearch is an association with a Head Office in Berne comprising the National Contact Points for the EU Research Framework Programmes, as well as Regional Offices providing consulting services at more than ten cantonal university locations.

In addition to Euresearch, the federal government also funds SwissCore (Swiss Contact Office for European Research, Innovation and Education), the liaison office for Swiss researchers and students in Brussels. Besides providing information and consulting services, SwissCore represents the interests of Switzerland's private and public sectors in questions of ERI policy vis-à-vis EU institutions and stakeholder groups in Brussels.

## European Union Educational and Mobility Programmes

International exchange and mobility contribute to strengthening the Swiss education system and labour market. The aim is to consolidate and enhance Switzerland's appeal as a location. From 2011 to 2013, Switzerland participated in EU educational, vocational and youth programmes such as "Lifelong Learning" and "Youth in Action" as an associated country. The goal of these programmes was to promote collaboration between educational and training institutions as well as the mobility of students at all educational levels in Europe. Replacing the earlier programmes, the follow-up programme Erasmus+ was launched in 2014. It runs until 2020.

### Innovation Promotion through Collaboration in European Networks

Enterprise Europe Network (EEN) helps SMEs to establish collaborations, engage in KTT and forge strategic partnerships. 600 regional member organisations in over fifty countries offer individualised, confidential support. In addition to brokering contacts, EEN provides advice to SMEs on matters relevant to them in connection with transnational cooperation programmes. Switzerland is a self-funding member of EEN. Under a gradual change of direction in Switzerland from 2016 on, EEN is to provide even more direct support in the regions to SMEs initiating innovation projects with foreign partners. Backup will come from regional innovation systems already in place or under development as well as from the CTI and its partners. Responsibility for implementing the change lies with the CTI, which assumed the lead of the EEN Switzerland consortium at the beginning of 2016.<sup>5</sup>

### 3.2.2 Organisations, Programmes and Infrastructures for International Research and Innovation Collaboration

In addition to participating in the European Union Framework Programmes, Switzerland is also a member country and active partner in other large intergovernmental organisations, programmes and infrastructures for international research and innovation collaboration. Being integrated into key international networks allows Swiss research and innovation actors to productively address questions together with international partners which would not have been possible alone. The tie-in with international networks also provides access to extremely costly experimental research facilities as well as to a very large pool of knowledge.

For instance, as a full member of the European Space Agency (ESA), Switzerland is entitled to take part in its programmes. It is one of the ESA founding countries and has jointly held the Agency chairmanship with Luxembourg from 2012 to 2016. ESA membership represents an R&D investment that contributes to promoting Switzerland's technological capabilities in the aerospace sector. As a return on Switzerland's membership fee, ESA con-

tracts are awarded competitively to Swiss companies and scientists in proportion to the fee. This is instrumental in developing and maintaining a specialised innovation-intensive industrial sector and creates jobs with high added value. ESA membership also promotes knowledge and technology transfer between research and industry as well as transfer out of the institutional European market into the global commercial market for aerospace technology and products.

Switzerland is also a member of the European Organization for Nuclear Research (CERN). CERN is a major basic physics research establishment. Huge particle accelerators are used to investigate the structure of matter. CERN's membership numbers 21 nations. A headcount of around 2,524 (end 2014) makes CERN the world's largest research centre in the area of particle physics. Over 10,000 guest scientists from 85 nations are working together on the various experiments. CERN's annual budget amounted to approximately CHF 1.1 billion in 2014.

What is more, Swiss researchers and companies can in some cases also take part in further international programmes, initiatives and infrastructures even where Switzerland is not a (full) member. Once such instance are the EU's Joint Technology Initiatives (JTIs), co funded under Horizon 2020. They are based on public-private partnerships (PPP) between the European Union and industry, focus on applied research and development and give SMEs and large corporations access to European research and cutting-edge technology. Another case in point are the EU's Joint Programming Initiatives (JPIs), which are designed to increase international collaboration by pooling the programming of national calls for proposals. The underlying rationale is to jointly address major Europe-wide social challenges that could not be tackled alone at national level.<sup>11</sup> The Framework Research Programmes (FPs) also encompass numerous other research and innovation initiatives, including the Future Emerging Technology Flagship Initiatives (FET Flagship Initiatives). The FET are large-scale long-term initiatives with a probable scale of action of around ten years and a budget of CHF 1 billion per flagship. Funding comes from the FPs and capital provided by the project partners and industry. Switzerland also participates in various ERA-NETs, which are likewise FP instruments. By strengthening transnational collaboration between research and innovation promotion organisations, ERA-NETs drive the networking of national and regional research and innovation programmes in specific thematic areas.

<sup>5</sup>The Euresearch Association has been mandated by SERI to provide EEN services for the promotion of international innovation, while SECO-mandated Switzerland Global Enterprise (S-GE) is responsible for EEN services in the area of international business marketing support.



## EPFL Rolex Learning Center

Switzerland has a long tradition of cooperation in research and innovation with the European Union. Researchers in Switzerland have been participating in the EU Research Framework Programmes since 1988, either as associated or third country partners. As for the newest programme generation 'Horizon 2020', Switzerland is fully associated since 2017. The access to Horizon 2020 provides Swiss researchers the chance to work on international projects with the world's research elite. The two Federal Institutes of Technology in Lausanne and Zurich play a key role among Swiss participation in Horizon 2020. The picture shows the EPFL Rolex Learning Center which is part of the campus in Lausanne.

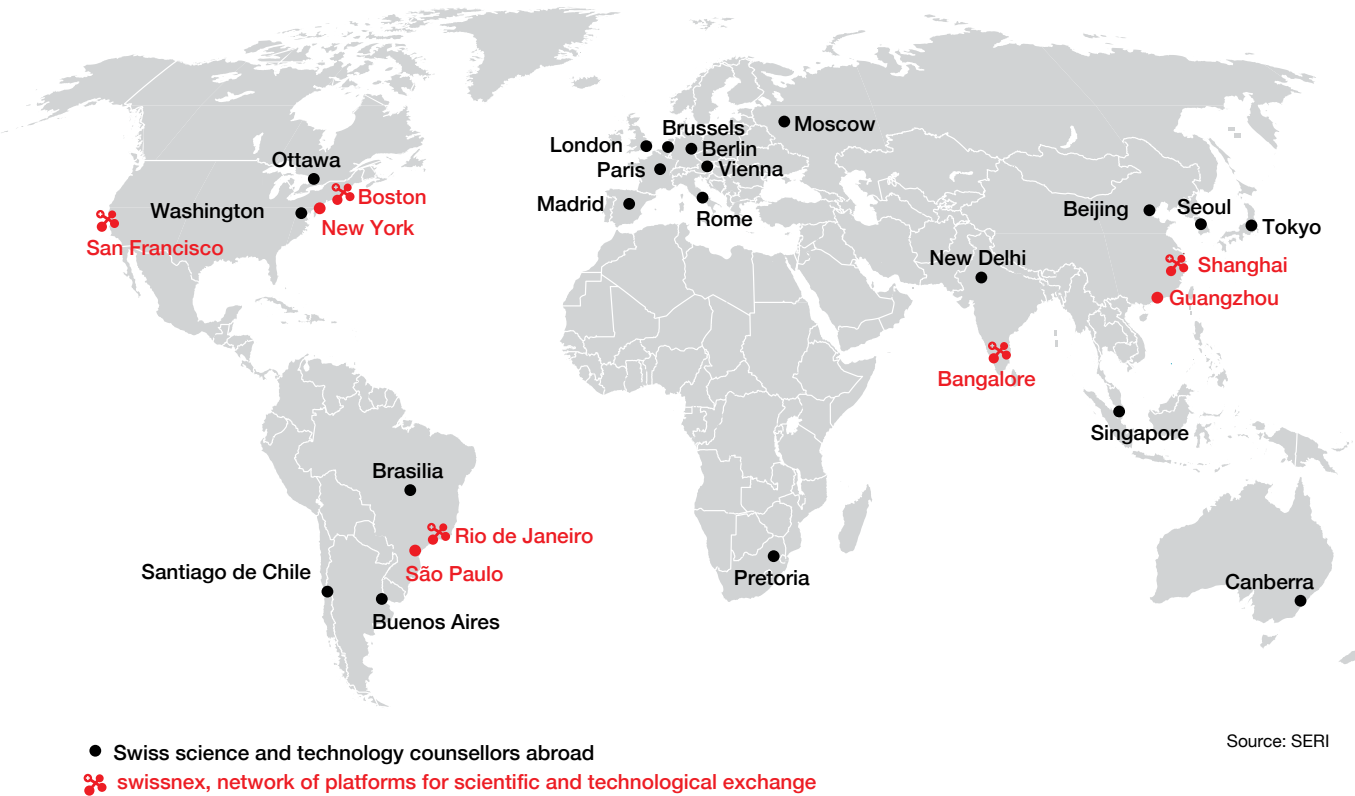




3.2.3 Bilateral Research Collaboration

Research collaboration with European countries is primarily under the mantle of multinational European research programmes and organisations. This Europe-centric multilateral foreign scientific policy is complemented by bilateral collaborations between Switzerland and non-European countries. Besides international scientific contacts via the ERI Network, the federal government has specific promotion programmes in place for research collaboration with priority countries. The objective of the bilateral research programmes is to strengthen scientific relations between Switzerland and the respective partner country in research areas of key strategic importance to both countries. Moreover, the international networking of Swiss tertiary and research institutions is intended to enhance their reputation abroad. Collaboration is based on the principles of scientific excellence, mutual interest and equally shared responsibility for funding. Bilateral programmes are currently ongoing with China, India, Russia, South Africa, Japan, South Korea and Brazil. In addition, various multilateral projects (with partners from China, Norway, France, USA, etc.) for the development of scientific instruments for aerospace research are being supported, plus a joint aerospace technology promotion project with partners from Austria.

Figure A 3.4: swissnex Network



3.2.4 swissnex Network and Other Federal Tools with an International Focus

In collaboration with and co-funded by the Federal Department of Foreign Affairs (FDFA), universities, the business sector, interest groups and private sponsors, SERI manages swissnex, a network of “scientific consulates” in Bangalore, Boston, Rio de Janeiro, San Francisco and Shanghai. Together with science and technology counsellors at 19 further locations worldwide, swissnex forms the swissnex Network. As one of the federal government’s international ERI strategy instruments, it supports and promotes the internationalisation efforts of Switzerland’s universities, scientists, and companies with close links to research.

A further instrument is Switzerland Global Enterprise (S-GE), which has been mandated by the federal government to bundle service level agreements for export, import and promoting Switzerland as a business location. S-GE promotes the implementation and spread of innovations by helping SMEs looking for export outlets secure access to foreign markets. S-GE has 21 Swiss Business Hubs on four continents. Their role is to advise Swiss exporters and also to promote Switzerland as a business location abroad.

3.3 The Federal Government’s Basic Stance on Research and Innovation Policy

Given Switzerland’s generally excellent positioning in the relevant global rankings, its research and innovation system appears well-structured with all the necessary core elements to ensure a high degree of effectiveness. In addition to structure, another crucial factor behind innovative leverage is the way that actors use the research and innovation system at their disposal and how they interact within it. This hinges largely on research and innovation policy, seen as the totality of promotion measures instigated by the public sector in this area.

The main focus of research and innovation policy is on the promotion of education and research in Switzerland. “Education policy is essentially built on two pillars: vocational and professional education and training (...) and academically based education (...). For the economy as a whole, this produces a good mix of different types of qualification – practical and application-oriented on the one hand, science-based and academic on the other – accommodating the realities of the business sector”. Research promotion places the emphasis on basic research, but does not neglect applied development. It follows in principle that the closer projects seeking funding are to the market, the less substantial state support should be. This is borne out by the fact that the annual federal contribution allocated to the SNSF is around seven times higher than the amount received by the CTI.

Unlike the EU Framework Programmes, public research and innovation funding in Switzerland does not entail direct payments to companies. What is more, there are no tax incentives for R&D activities, such as in the form of tax relief or indirectly via public procurement, as recommended by the OECD.

Public research and innovation promotion decisions are informed primarily by researcher initiative, the principle of competition, and qualitative assessment criteria for applications: The bottom-up principle is predominant. Individual research teams or companies are expected to take the initiative for R&D and innovation activities and themselves assume the responsibilities and risks. Individual projects receive state funding on the basis of a competitive application process and an evaluation procedure that is focused on excellence. Applied research with a business bias generally shuns top-down programme funding. In the area of near-basic research, this does not rule out a priori a policy-led focus on key strategic themes, as the example of NCCR shows. However, key themes tend to materialise as part of a follow-up programme picking up and building on positive trends, which in turn come about as the result of bottom-up developments.

The bottom-up principle also goes hand in hand with the prevailing view that innovations are primarily the result of entrepreneurial actions and thus the archetypal task of companies. The private sector bears the main responsibility for

innovation processes. Within a regulatory framework, it wants and should be given sufficient freedom to pursue these processes. The state limits itself to a subsidiary role, creating favourable conditions and an attractive climate for innovations, such as an effective education system and a high-calibre education and research infrastructure (enabling). State innovation promotion is directed at giving people opportunities, within their spheres of action, to develop their talents to optimum capacity and produce internationally competitive top achievements in selected areas. This includes ensuring that, measured against other countries, Switzerland enjoys great appeal as a location for innovative firms, researchers and skilled workers.

**Switzerland has, in effect, a federal paradigm of innovation promotion. The central approaches and principles are as follows:**

- The key driver of innovation is competition where the competitors are not only companies, but also universities and non-university research establishments. Innovation policy is aimed at allowing and respecting existing or newly forming competitive relationships between public and private actors in the innovation system. It ensures that state involvement in education and research distorts competition as little as possible. Recognising and upholding the autonomy of universities is a sine qua non.
- Innovation policy is directed at enhancing the flexibility and adaptability of actors in the business and university sectors, at sharpening their ability to absorb new ideas and at supporting the concomitant structural change. This includes driving the rapid implementation and dissemination of the state of the art (diffusion-oriented business policy). Given their economic significance and presumed potential to create value added and jobs, but also in light of their structurally rooted problems and bottlenecks, technology and export-oriented SMEs and start-ups are a particular target group for innovation policy measures.
- Innovations very frequently occur in networks of large corporations and SMEs, suppliers and customers, public and private research and innovation institutions, as well as education establishments, association and authorities. Innovation policy is geared to helping facilitate and improve collaboration in such networks. Good framework conditions create an important basis for research and innovation collaborations between universities and the private sector. The large majority of such collaborations come about directly between partners, without any direct federal involvement or funding.

As shown above, innovation policy touches on many policy areas, notably education and research policy, competition and labour market policy, location and regional policy, and finance policy. A further key source of momentum are sectoral policies such as the healthcare, environment, energy and transport portfolios. Innovation policy is cross-sectional and needs to factor in the connections and interactions between numerous policy areas and their actors. This calls for measures to be coordinated and synchronised.



In addition to having a materially diverse innovation policy, Switzerland's skill resources are spread across different institutions and actors, nationally over the three administrative levels of Confederation, cantons and municipalities, and internationally over states and communities. Coordination demands a considerable amount of time and expense and is one of the main obstacles to an effective innovation policy. Innovation policy in Switzerland is normally based on negative coordination, i.e. the review and avoidance or prevention of any negative influence of a decision variable on the status quo or the interests of other functionally related units.

An innovation policy founded on a universally recognised concept drawn up jointly by political and business proponents and with the explicit coordination of the actors involved does not exist in Switzerland, or only rudimentarily as recently seen in the Cleantech Masterplan, the Green Economy Action Plan or the strategy to strengthen the role of regional innovations systems (RIS Strategy) under the New Regional Policy. Any such stipulation goes beyond present practice.

Much of Switzerland's innovation promotion policy is implicit. The policies of different innovation institutions and actors reflect different priorities, e.g. economic growth, research excellence, energy efficiency, or sustainability. Since innovative activities are aimed at achieving these objectives, innovation policy is driven by a fragmented system in which various actors and institutions pursue their own agendas. Efforts undertaken in different policy areas relevant to innovation output contribute indirectly to Switzerland's excellent innovative track record.

Funding from the private sector is a further hallmark of innovation promotion in Switzerland. Complementing federal grants, it is used to finance start-ups or support the scaling-up of start-ups in privately funded technoparks. Start-up launches are funded by different forms of public-private partnership, such as between the CTI (state) and CTI Invest (private).

This type of research and innovation promotion provides a solid context in the form of a strong educational and research base and attractive conditions for innovation activities, with very little state intervention and regulation by international comparison. Given the immense challenges and pitfalls that blanket coordination of the various policy areas would bring, this is most likely the optimum pragmatic approach for Switzerland.



## NCCR

National Centres of Competence in Research (NCCRs) aim to strengthen Swiss research in areas of strategic importance for the future of Swiss science, business and society. The programme seeks to promote research projects of the highest quality with a particular emphasis on interdisciplinary approaches, but also on new, innovative approaches within the disciplines. The budget for each series of NCCRs is determined by parliament and implemented by the Swiss National Science Foundation. In addition to federal funds, NCCRs receive funding from higher education institutions and from third parties.

ETH Zurich hosts the NCCR Digital Fabrication, which is Switzerland's initiative to lead the development and integration of digital technologies within the field of architecture.





# Swiss Innovation in International Comparison

## Affective Sciences

The University of Geneva is home to the national centre of competence in research (NCCR) "Affective sciences – emotions and their effects on human behavior and society", one of the leading research centres in the world dedicated to the interdisciplinary study of emotions. Researchers study the origin of affective states and emotions, control of them and their social functions. In their experiments they use electroencephalographs, which allow them to measure brain activity by means of electrodes. The result of this research helps to improve people's physical and psychological health, to increase their well-being within the family and at work and helps them to develop the ability to manage their emotions.



# Swiss Research and Innovation in International Comparison

The Swiss research and innovation system is very productive. A comparison of Switzerland with its main competitors and business partners places it among the highest-ranking countries in the field of research and innovation.

On the whole, though, the differences between the various countries are narrowing. For this reason, particular attention needs to be paid to those areas where Switzerland's performance leaves some scope for improvement and where it could fall behind.

## Framework Conditions

An investigation of the framework conditions for research and innovation reveals a very positive picture for Switzerland. Switzerland features among the frontrunners for the majority of indicators. It has a high-calibre infrastructure in place. Corporate taxes are very low. Among the reference countries, Switzerland has the most flexible labour market. The quality of life is excellent, and new businesses face only minor obstacles. However, in terms of how long it takes to establish a company, Switzerland finds itself in the middle rankings among the reference countries.

## Education and Qualifications

The Swiss research and innovation sector can rely on the quality of the education system. While the percentage of the population with a higher education qualification in Switzerland is not especially high, it has to do with the significance of vocational training. This is a decisive factor in the education and training of the qualified personnel that business and society need. The outstanding results that Switzerland achieves in the area of research and innovation can be explained in part by the marked internationalisation of the education system. The excellent reputation of Switzerland's higher education institutions makes it an attractive choice for students and doctoral candidates from other countries. On the other hand, Switzerland has not reached its full potential in respect of the number of natural sciences and engineering students.

## Personnel in Research and Innovation

Switzerland boasts an outstanding pool of human capital, a considerable proportion of which work in science and technology. However, measured by the share of researchers in the total workforce, it sits in the lower rankings among the reference countries. The share of women in the total research labour force also presents a challenge for Switzerland. Its competitiveness could also be diminished by the increasing difficulty that companies and research establishments face in recruiting the talents they require to maintain their innovative capabilities.

## Expenditure on Research and Innovation

Switzerland ranks among the countries with the highest ratio of R&D investment to gross domestic product (GDP). Private firms account for just under two thirds of R&D expenditure. This high private-sector share testifies to the attractive framework conditions enjoyed in Switzerland by companies working in knowledge-intensive sectors. Responsible for over 25% of total R&D expenditure, Switzerland's higher education institutions also play a key role. The pharmaceutical industry is the main beneficiary of R&D output in Switzerland.

## Funding of Research and Innovation

In common with all other reference countries, the bulk of R&D funding in Switzerland comes from the private sector. However, the Swiss federal government and the cantons have a long tradition of funding R&D, regardless of economic trends. Research grants are continually being increased. Switzerland lies in the middle when it comes to venture capital, its efforts in this area proving relatively modest compared to the USA.

## Participation in EU Research Framework Programmes

Switzerland has a long history of participating in international research programmes. The number of Swiss project participations under the FPs is comparable with other small countries, but has been rising continually between 1992 and 2013. The same applies – with a higher growth rate – to grants awarded to researchers in Switzerland. The high success rate for Swiss project proposals is worthy of mention.

## Scientific Publications

Switzerland has achieved some remarkable results as regards scientific publications. Despite growing competition from certain emerging countries, it maintains an output of scientific articles that is considerable for its size. The impact of scientific publications produced in Switzerland is also impressive. The Swiss research sector's strong international reach is attributable to the fact that Switzerland's researchers very frequently work with foreign research institutions. Switzerland occupies a prominent position in the fields of physics, chemistry and the geosciences in terms of all indicators of production, impact and collaboration.

## Patents

Switzerland is a leader in the patent rankings. Measured against the country's population, the number of patent applications is particularly high here. Also warranting a mention is its strong global patent presence, which is borne out by the patents resulting from international collaborations and the patent applications filed by foreign companies. This serves to demonstrate the strong appeal of the Swiss research and innovation system. A breakdown by individual sectors shows that Switzerland's strengths lie in the areas of health technologies and biotechnology.

## Knowledge and Technology Transfer

Switzerland stands out for efficient KTT. The close ties between higher education institutions and the corporate sector help to explain the success of the Swiss research and innovation sector. That said, there is still some leeway for improvements given that, in Switzerland as elsewhere, there is a very strong correlation between intensity of KTT and firm size.

## Innovation Activities of Firms

Swiss companies have a very good track record overall when it comes to innovation activities. What particularly sets Switzerland apart from the reference countries are the outstanding achievements of the SMEs. In all probability, these successes are due to the diversity and density of local business systems in specific special fields.

## Economic Performance

With regard to economic output, Switzerland is well positioned, as measured both by the percentage of companies active in knowledge-intensive areas (high-tech industry and knowledge-intensive services) and by exports of high and medium-tech products.

## Comparison with Innovation Regions

A comparison with regions with a strong focus on research and innovation<sup>6</sup> confirms Switzerland's excellent positioning. However, the result is less impressive than in the comparison against the reference countries. For instance, the ratio of R&D spending to GDP is considerably higher in Baden-Württemberg and New England. Switzerland's volume of publications per researcher is only marginally ahead of the figures for New England and Lombardy/Piedmont. Measured by the number of patents per 1000 inhabitants, Switzerland is clearly surpassed by Baden-Württemberg and Bavaria. These two innovation-centric regions in Germany also rank ahead of Switzerland on several other innovation indicators. Expressed as a percentage of the total work force, the number of people employed in Switzerland's research and knowledge-intensive sectors place it in the middle range, although high-tech industries have a stronger presence in Switzerland than in most of the analysed innovation-centric regions. It must also be borne in mind, though, that these regions profit from the size of the countries that they are located in. They can draw on a pool of talents and ideas from an entire large nation, while small Switzerland has to make up for the size disadvantage by adopting an open stance.

<sup>6</sup>The following regions were selected for comparison: Baden-Württemberg and Bavaria in Germany, Northwest Italy (Lombardy and Piedmont), the Greater Paris area (Ile-de-France), the Greater London area (South East England) and the US New England states in the narrower sense.



Figure B 1.1: Quality of the infrastructure, 2014

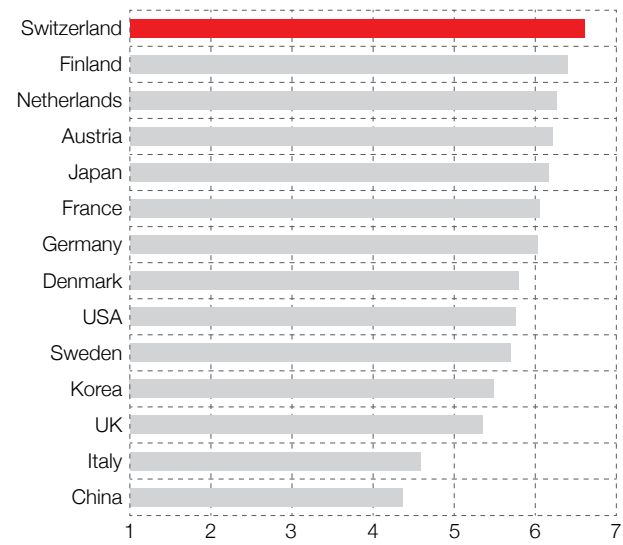
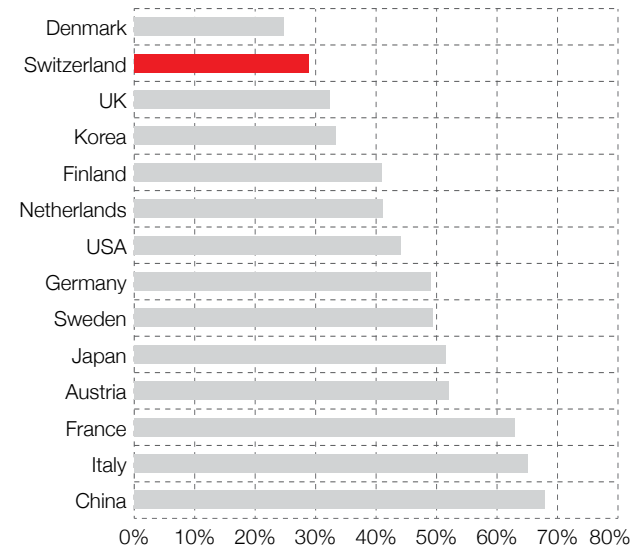
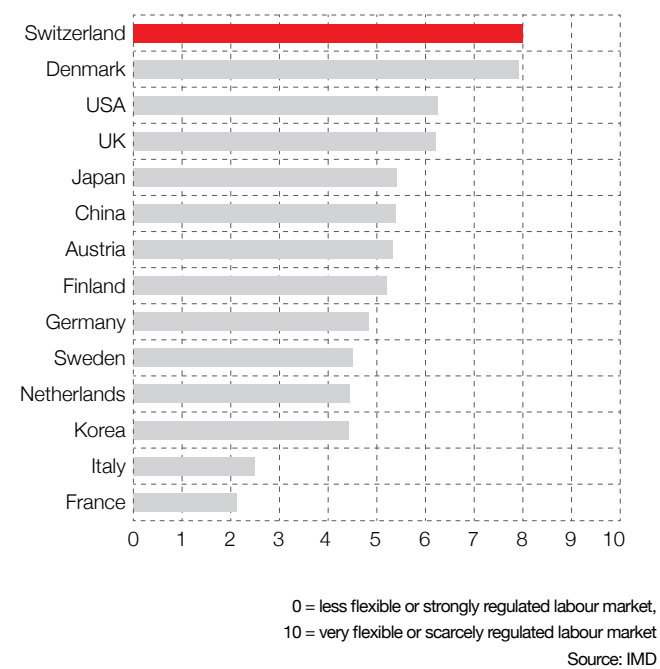


Figure B 1.2: Total corporate tax rate, 2014



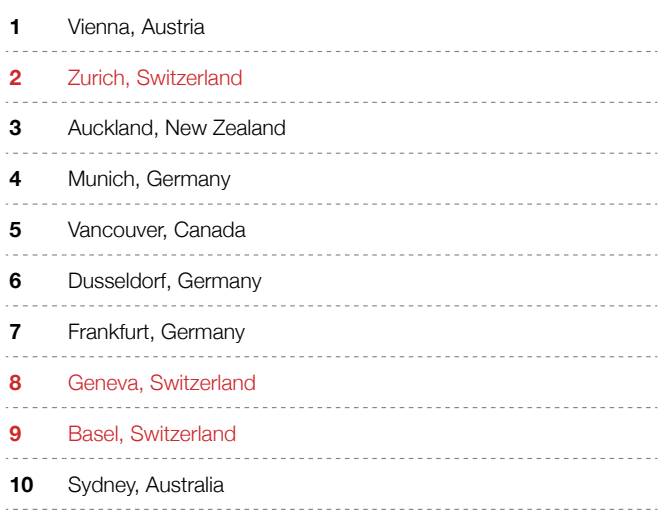
Source: World Bank

Figure B 1.3: Labour market flexibility, 2014



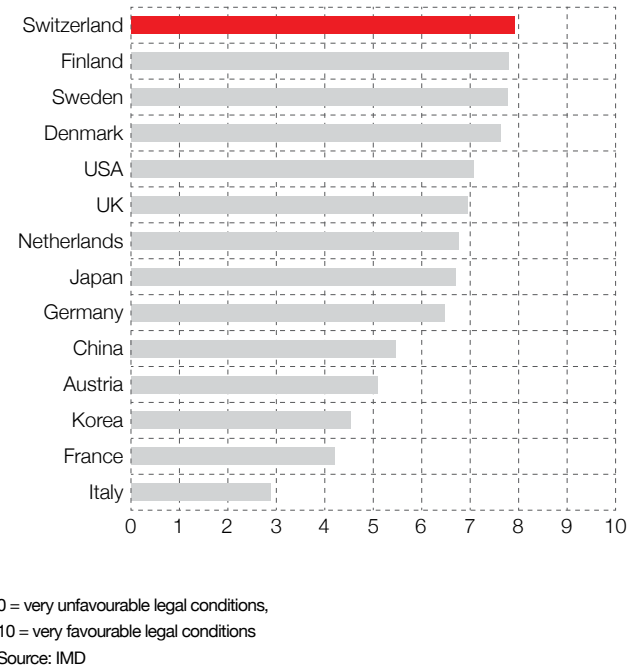
Source: IMD

Figure B 1.4: Quality of life according to city ranking (top 10), 2016



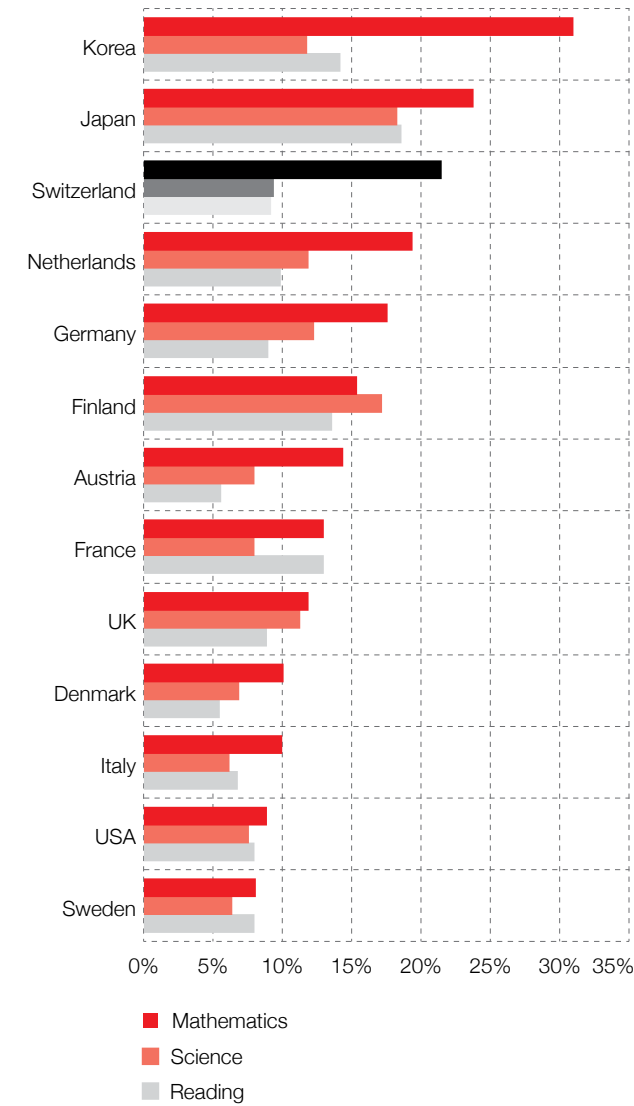
Source: Mercer

Figure B 1.5: Ease of starting a new business, 2014



Source: IMD

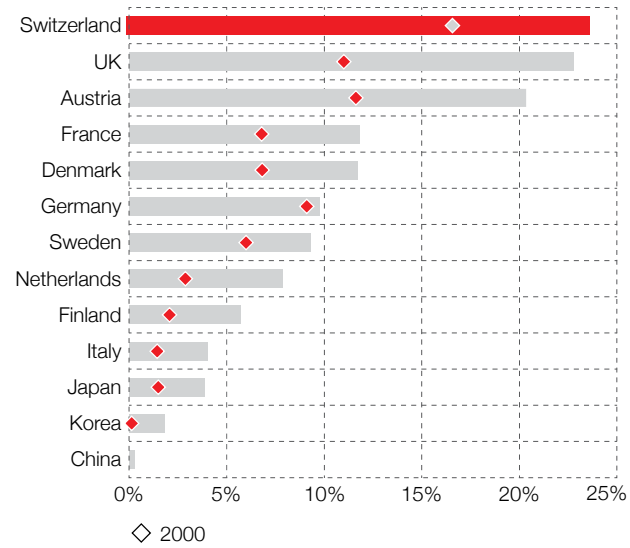
Figure B 1.6: Share of young people with very good proficiency in mathematics, science and reading, 2012



Young people aged 15 who received a PISA survey rating of 5 or 6 in the corresponding subject  
No data available: China  
Source: OECD

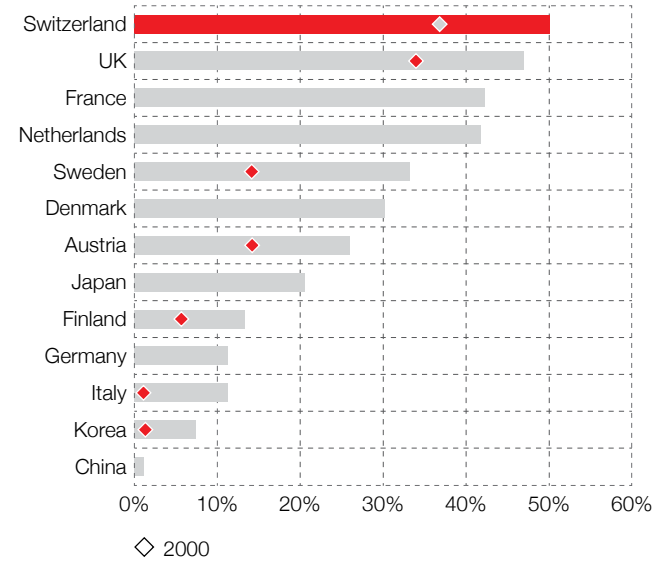


Figure B 1.7: Share of foreign students among all students at tertiary level, 2012



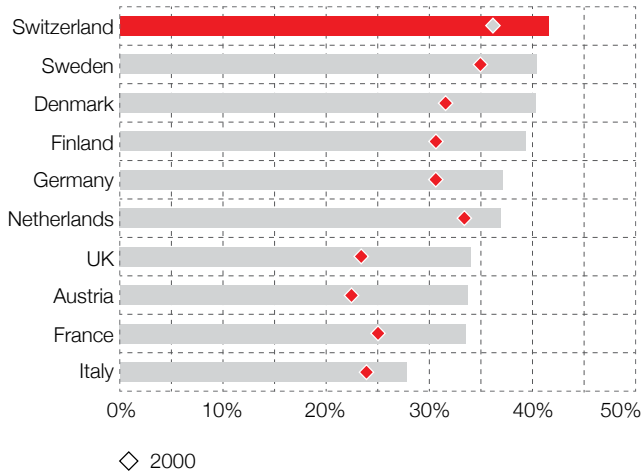
No data available: USA  
Source: OECD, KOF calculations

Figure B 1.8: Share of foreign doctoral students among all doctoral students, 2012



No data available: USA  
Source: OECD, KOF calculations

Figure B 1.9: Share of the workforce employed in science and technology, 2014



Working population aged 15 to 74  
(exception: Switzerland: people aged 15 to 64)  
No data available: Japan, Korea, USA, China  
Source: EUROSTAT



# Fundamentals and Further Analysis

## “Research and Innovation in Switzerland” Report



**This Brochure is based on a more extensive report which was published by SERI in 2016.**

- It describes the Swiss research and innovation system's structure and how it works. It explains the fundamentals of how the system is run and the role of the various players involved.
- It provides a global, long-term analysis of the Swiss research and innovation system with the use of quantitative and qualitative indicators. The report compares the Swiss research and innovation system with other developed and emerging economies over a period of several years. Various indicators relating to investment, interaction and performance are presented.
- It contains thematic studies: in each report, selected topics within the research and innovation system are examined more closely. These analyses are conducted by experts.

Further information and ordering options:  
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International university rankings:  
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