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Research Report

Challenges for the Swiss Innovation System

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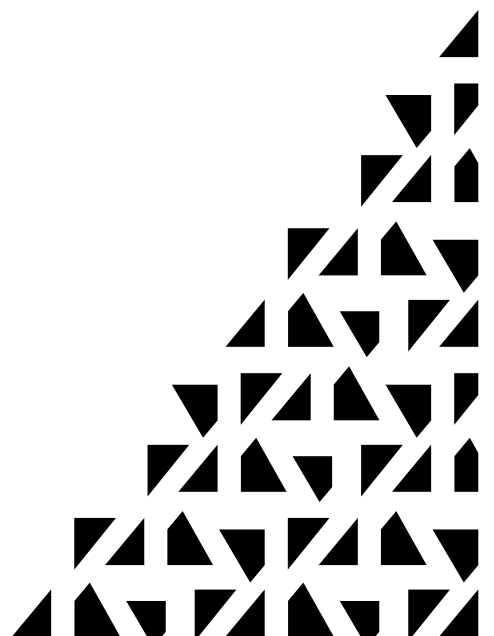
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Challenges for the Swiss Innovation System*

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Abstract

The Swiss Innovation System is the most powerful instrument to achieve continuous improvements in material well-being for citizens in Switzerland, and for addressing challenges such as protection against cyberattacks or providing clean energy. Yet, the Swiss Innovation System and its successes are challenged in multiple ways today. The Swiss lead in innovation has declined and the share of firms performing R&D has decreased. Other major countries undertake large-scale industrial subsidies to promote innovation and relocation of economic activities. This raises the question whether the Swiss Innovation System should also be adjusted. The framework of the Swiss economic system—strong focus on basic research, linking public institutions of higher education with industry, and few direct subsidies—is a promising approach for the future. A strong public research sector combined with steady enhancements of the Swiss knowledge and technology transfer capacity, as well as variations of existing instruments at *Innosuisse* or tax credits at the cantonal level for R&D expenditures could further boost innovation efforts in the private sector. Such measures would also be an appropriate response to international challenges such as the OECD minimum tax. Moreover, the success of the Swiss Innovation System relies crucially on other framework conditions, in particular on the open access to international markets for goods and services and on the ability to attract researchers from around the world as well as on entrepreneurship of residents in Switzerland.

Keywords: Basic Research, Applied Research, Swiss Innovation System,
OECD Minimum Tax

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1 Introduction

Private sector innovation, i.e., new products, services or resource-saving production processes developed by private firms, is one of the main drivers of long-term improvement in material well-being and essential for the solution of major societal challenges such as fighting climate change, developing new antibiotics against resistant bacteria or providing solutions against cyberattacks. These activities in the private sector are supported and stimulated by the public sector, and they depend on scientific advancements in basic research. In industrialized countries, this occurs through three channels.

First, the main share of basic research—around three-quarters—and a minor, but significant share of applied research are either done by or funded by the public sector. Second, countries can foster innovative activities of the private sector by subsidies or tax incentives for R&D activities, which have gained in importance in recent times (see OECD (2023b)). Third, governments can provide infrastructure such as technology centers to stimulate R&D activities in general, or allocate funds for specific research activities to direct R&D activity to certain technologies or applications (for instance the military, clean energy, antibiotics or protection against cybersecurity risks). An empirical overview of public support for R&D can be found in Gersbach et al. (2021) and OECD (2023b).

Mission-oriented government R&D support that integrates these channels has always been part of the policy toolkit, for instance in the US. Recently, we have observed the CHIPS Program,¹ whose aim is to promote cutting-edge chip production in the US by using all three channels, and even supporting production directly. Moreover, we have observed large-scale industrial subsidy programs to direct R&D activities into particular areas in the US. The most prominent of these is the US Inflation Reduction Act of 2022 but large subsidy programs have also been initiated at EU level, in China, and in many European countries.²

In this landscape, the Swiss system is characterized by a strong focus on basic research and programs that link institutions for higher education and the industry, with comparatively few subsidies to the industry for innovative activities. Other approaches, such as extensive direct R&D subsidies for firms or even large-scale direct industrial subsidy programs to develop entire industries, are not common.

In this article, we review the Swiss Innovation System and its rationale, document its current challenges and discuss how it could cope with these challenges. Overall, we

¹CHIPS and Science Act, <https://www.nist.gov/chips> (accessed November 28, 2023).

²Inflation Reduction Act of 2022, <https://www.govinfo.gov/content/pkg/PLAW-117pub1169/us1m/PLAW-117pub1169.xml> (accessed November 28, 2023).

find that the unique features of the Swiss system are likely to make a key contribution to success in the future. Thus, maintaining the physical and intangible infrastructure that constitutes the Swiss Innovation System is essential. Adding more knowledge and technology transfer capacity could promote innovation efforts in the private sector and varying the instruments at *Innosuisse* or tax credits for R&D expenditures at cantonal level could further stimulate innovation activities and provide an answer to the OECD minimal tax requirements. The success of the Swiss Innovation System also relies crucially on other general conditions, in particular on the open access to international markets for goods and services and on the ability to attract researchers from around the world, as well as on entrepreneurship of residents in Switzerland.³

The paper is organized as follows: In Section 2, we present the Swiss innovation system and its rationale. In Section 3, we address its main challenges. In Section 4, we suggest ways to proceed from now on. Section 5 concludes.

2 The Swiss Innovation System

The Swiss Innovation System is strongly relies on basic and (to a smaller extent) on applied research that is undertaken by institutions of higher education. The literature has found that basic research impacts applied research in the private sector through a variety of channels (Aghion and Howitt, 1996; Cozzi and Galli, 2009; Gersbach et al., 2013; Spinesi, 2013; Gersbach and Schneider, 2015; Cozzi and Galli, 2017; Gersbach et al., 2018; Gersbach et al., 2021; Akcigit et al., 2021; Jones and Summers, 2022 and Gersbach et al., 2023a). These channels include open science (e.g., publications, scientific reports, conferences) that expands and deepens knowledge—including far-reaching discoveries—, “embodied knowledge transfer” associated with scientists moving from basic to applied and experimental research in firms, collaborative and contracted research ventures, informal interaction between basic and applied researchers, joint industry-university research centers, academic consulting and the patenting and licensing of university inventions. Furthermore, one can observe that innovative firms tend to locate in the vicinity of universities and new start-ups are often launched as spin-offs from university research groups. Recent studies find large returns to innovation in general (Jones and Summers, 2022) and to investment in basic research in particular (Akcigit et al., 2021).⁴

³Vocational education and training (VET) is also an important part of the Swiss innovation system, as a well-trained labor force facilitates the undertaking of innovation activities, which is of particular relevance for SMEs. However, this aspect cannot be analysed further in this study.

⁴While the spillovers from basic to applied research have been widely documented, fewer studies have dealt with the reverse relationship of spillovers from applied to basic research. In that regard, it is argued that while science certainly has induced the development of new technologies and applications, in many

Since many of these benefits are local, regional or at the country level, there is a clear rationale for a small open economy to undertake investment in basic research (Gersbach et al., 2023b). In a nutshell, public funding for basic research undertaken by institutions of higher education and other specialized institutions supports the R&D-intensive sectors in Switzerland through the channels outlined above, and provides knowledge, graduates and technologies for the entire economy.

Exactly how much basic research should be conducted by a small open economy is a tough question. While it is impossible to provide a precise quantification, the literature has identified four factors that influence the optimal amount of investment in basic research (Gersbach et al., 2021): (1) a country’s stage of economic development, (2) its share of R&D-intensive industries, in particular its manufacturing and information and communication technology base, (3) a country’s openness, and (4) its share of domestic firms owned by foreigners. In short, a country should invest the more in basic research, the closer it is to the technological frontier, the higher its share of manufacturing, information and communication technology sectors in GDP, and the more open its economy.

The reasons are as follows. First, by increasing the innovativeness of domestic firms, basic research indirectly increases their productivity and makes them more competitive in the world market. Intuitively, the expected gains from basic research investment then are the larger, the higher the potential returns from providing innovative products and services to the world market. Second, the larger the amount of private sector R&D activity in a country, the larger the gains from basic research. This is the case when the size of the manufacturing sector and of the R&D-intensive service sector is larger. Third, in supporting innovation, basic research helps firms to maintain their monopoly positions via new patents and to deter foreign firms from entry. It also helps to attract new firms, and induces start-ups to commercialize knowledge created by basic research. This is particularly relevant when domestic firms are close to the technological frontier. These gains from basic research have to be compared to its costs. For instance, public investment in basic research might bid up wages for skilled labor, which could feed back into the incentives to undertake applied and experimental research by the private sector.

Since Switzerland scores high in openness, R&D-intensive industries and closeness to the technology frontier, a strong focus on basic research investments follows from the arguments above. In Figures 1 and 2, we show the share of value added from manufacturing in GDP across several countries. We see that Switzerland maintains a strong manufacturing sector. Switzerland also scores high in terms of trade openness, which is, of course, also the result of the size of the economy (see Figure 3). Importantly, it has a particularly high share of exports compared to other industrial countries (see Figure 4), and is thus

instances these new technologies have also lead to the rise of new scientific fields.

heavily exposed to international competition with technologically-leading firms.

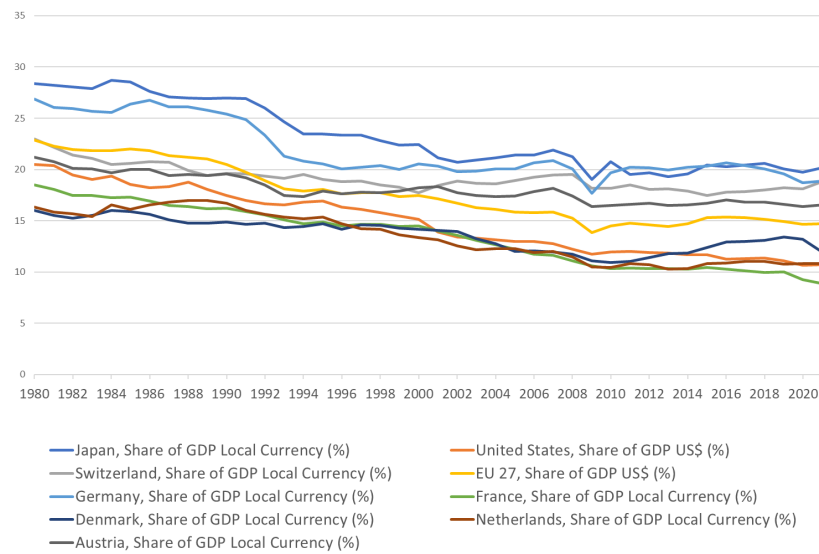


Figure 1: Manufacturing share to GDP for selected countries. Source: United Nation Food & Agriculture Organization, accessed 18.12.2023.

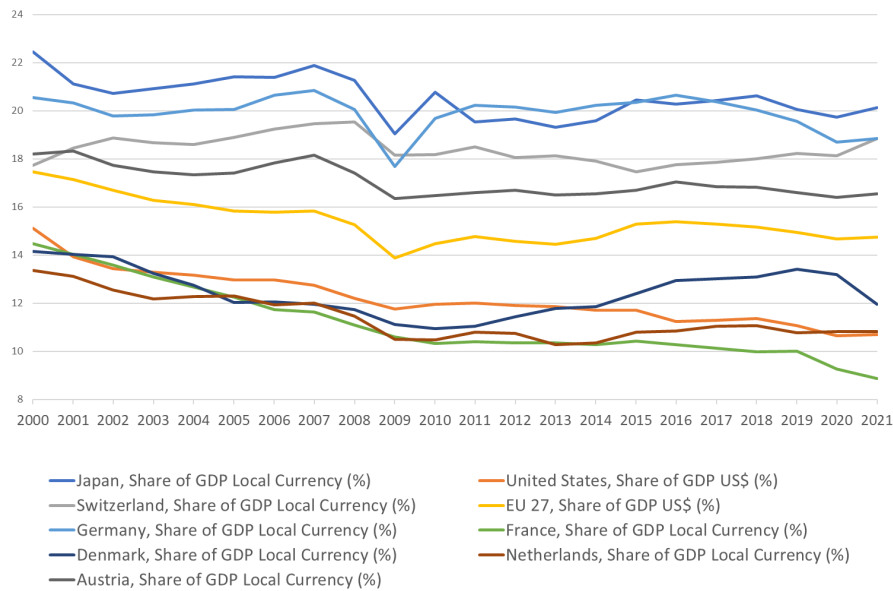


Figure 2: Manufacturing share to GDP for selected countries. Source: United National Food & Agriculture Organization, accessed 18.12.2023.

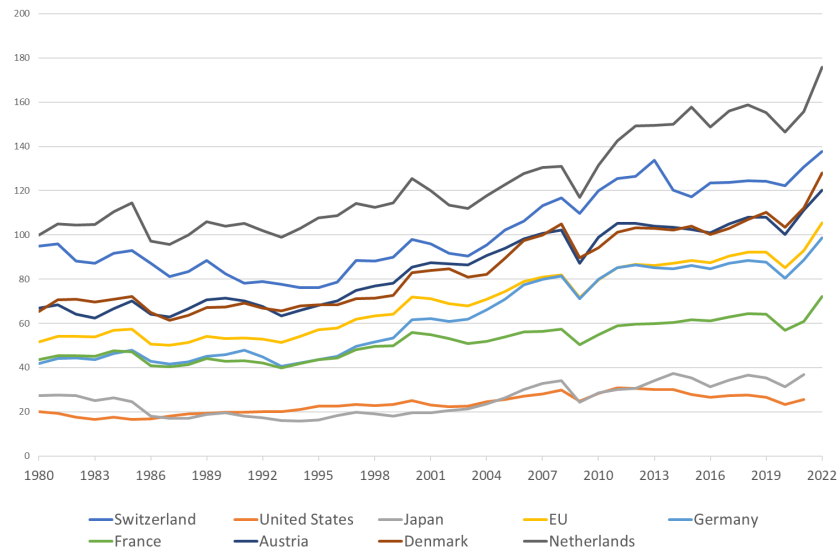


Figure 3: Trade share (goods and services) to GDP for selected countries. Source: World Bank, Development Indicators (WDI), accessed 18.12.2023.

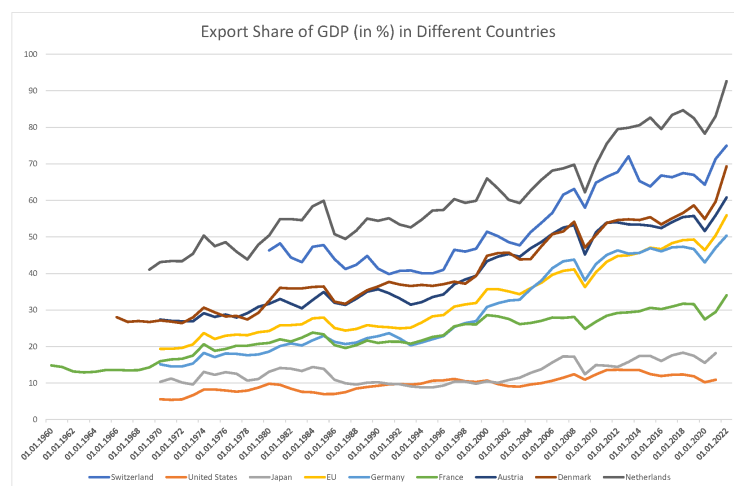


Figure 4: Export shares (goods and services) of industrial countries. Source: World Bank, World Development Indicators (WDI), accessed 18.12.2023.

3 Challenges for the Swiss Innovation System

3.1 The main challenges in a nutshell

The Swiss Innovation System and the Swiss economy face multiple challenges. First, Switzerland’s position in developing new technologies and products is being challenged. Second, policy-makers in major countries debate about the future of globalization, and geopolitics are changing the landscape of world trade and international capital investments. In particular, China, the EU, individual EU countries and the US have embarked on large-scale industrial subsidy programs to reduce external dependencies by widening the possibilities for domestic sourcing of local firms, with the goal to achieve self-sufficiency in key technologies. Building up production or reshoring production are explicit objectives in programs such as the CHIPS Act and Inflation Reduction Act in the US, the Intel case in Germany,⁵ various industrial subsidy programs in China to advance “strategic industries”, and the European Chips Act (ECA)⁶. Third, the OECD countries have decided to introduce a minimum tax.⁷ For Switzerland, this means a relative loss of attractiveness as a business location. The question now is which measures, if any, can be taken to counteract this loss.

3.2 Evidence

It is useful to discuss in more detail the challenges that the Swiss innovative system faces and to examine where Switzerland stands regarding innovative activities.

International innovation competition: Geopolitical factors have clearly intensified international innovation competition. In some sectors, for instance in mechanical, electrical and metal (MEM) industries and in Medtech, it has become much more difficult for Swiss firms to differentiate themselves from foreign competitors (especially from Asia) through new technologies. There is also increased competition across sectors. This applies not only to companies such as Amazon, who has intensified competition in retail and cloud services, but also to the healthcare sector or the banking sector, where incumbents are increasingly competing with Google, Amazon, Meta, Microsoft, Apple and other large IT companies and small start-ups.

⁵<https://www.intel.com/content/www/us/en/newsroom/news/intel-german-government-agree-magdeburg.html> (accessed November 28, 2023).

⁶<https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52022PC0046> (accessed November 28, 2023).

⁷See OECD (2023a).

Digitization: Swiss companies face major challenges, particularly in the area of digitization. Digitization is not a new phenomenon, but it has intensified in the wake of new technical possibilities in the area of processing and analyzing large amounts of data by machine-learning applications and the latest developments in the field of artificial intelligence. These developments open up new areas of business and offer opportunities for the development of new products and services, for example in the financial and healthcare sector. These technological opportunities can only be exploited if the required skills are available in sufficient quantities. From the companies' point of view, the Swiss education system is currently unable to meet this demand for skills. In particular, small and medium-sized enterprises (SMEs) find it difficult to meet their skill needs through cooperation with academic institutions. As a result, many companies are at risk of being left behind. They are unable to digitise their processes, products and services to the extent and at the speed required to remain competitive on an international level (Barjak et al., 2023).

Regulation: Regulation has become more important and increasingly frames the innovation activities of Swiss companies. This is true at least in sectors with certain sensitivities, such as the energy sector, the health sector, the financial sector, and IT. For instance, the regulation of product approval/certification with regard to environmental and sustainability issues as well as the regulation related to intellectual property and market access, have become more strict. Tighter regulation increasingly influences the possibilities of product development, market timing, production processes, and corporate location choices. While new regulations are challenging for established companies, they might also provide innovative space for new entrants and business models (Barjak et al., 2023).

Switzerland often has to adopt EU regulations in order to allow its companies to export to these markets. This adoption process, however, is often slow or even blocked for political reasons (e.g., Horizon Europe), leading to increased uncertainty in large parts of the Swiss economy and weakening the position of Swiss companies against their foreign competitors. As a result, R&D-intensive companies are increasingly pursuing their innovation projects abroad. The amount of Swiss private R&D expenditures in foreign locations has increased from 9.8 billion CHF in 2000 to 15.9 billion CHF in 2021 (FSO (Federal Statistical Office), 2023).⁸ Studies also show that knowledge from research abroad is key to the development of economically successful innovative products (Arvanitis et al., 2023). The difficulty to have immediate access to foreign knowledge because of regulatory and political hurdles is a major challenge for Swiss companies.

8

<https://www.bfs.admin.ch/bfs/de/home/statistiken/bildung-wissenschaft/technologie/indikatorsystem/zugang-indikatoren/w-t-input/f-e-aufwendungen-privatwirtschaft.assetdetail.1.25025901.html> (accessed on November 28, 2023).

High innovation costs, lack of skilled labour: In addition to the general challenges discussed above, Swiss companies face very specific problems that hamper their innovation efforts. Figure 5 shows the barriers to innovation that Swiss firms consider to be the most restrictive.⁹ More than 14% of Swiss enterprises consider high innovation costs to be the most important problem that prevents them from investing more in innovation activities or from starting innovation activities in the first place. Other major problems seem to be a lack of internal resources and a long payback period for innovative products and services. Notably, the problem of a lack of skilled labour has clearly become more severe in recent times.

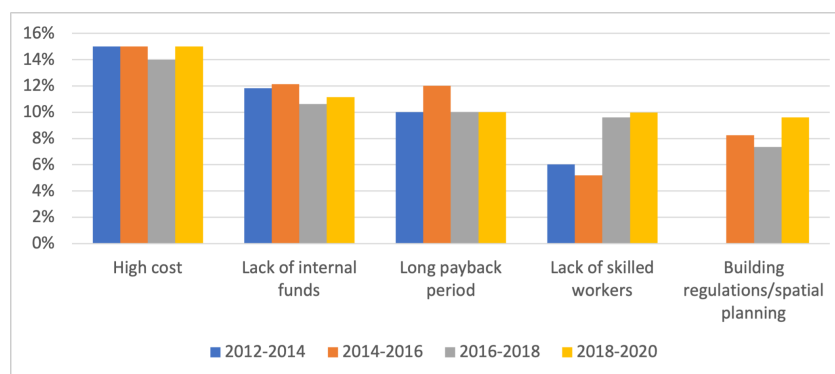


Figure 5: Important obstacles to innovation. Source: KOF Innovation Surveys.

Obviously, these impediments to innovation activities are common in many countries and are, to a large extent, inherent in R&D markets. Yet, the increase in the last two categories in Figure 5 points to an increasingly difficult environment for innovative activities in Switzerland.

Fewer R&D active companies, more incremental innovation: Although Swiss companies face a number of challenges and obstacles, Switzerland remains one of the most innovative countries in the world. According to the Global Innovation Index, it ranks first for the 12th time in a row (World Intellectual Property Organization (WIPO), 2022). Switzerland performs especially well on patent-related indicators. However, while patents are an important indicator for R&D activity, they reflect only a small part of a country's total innovation activity. In Switzerland, only 2.7% of companies with more than 5 employees are patenting, while more than 40% innovate, i.e., produce new or significantly modified products and services (Spescha and Wörter, 2022).

When taking into account other innovation indicators, for instance R&D indicators that directly relate to the efforts in creating new products and services, the picture is mixed. Figure 6 shows a sharp decline in the share of enterprises engaged in R&D. This share

⁹The figure is based on data from companies that are part of the KOF enterprise panel. This panel is representative for Swiss companies with more than 5 employees, covering the manufacturing, construction, and service sector.

has almost halved since 2000. In contrast, the share of enterprises that outsource R&D to other enterprises and institutions increased significantly after the global financial crisis 2008-09 and the share of enterprises with R&D activities abroad also increased, albeit from a low level. Overall, Figure 6 indicates that Swiss firms have become less R&D-intensive overall, but more open and international in this regard. This is a considerable challenge for Swiss SMEs in particular.

It is intuitive that R&D-intensive companies succeed more often in producing significant innovations and thus have competitive advantages in the market. Figure 7 compares firms that are active in R&D to those who are not, in terms of value added per employee (in CHF). Firms active in R&D show higher values, especially in the group of very productive companies. This underlines the economic importance for Switzerland to have companies that are active in R&D.

The costs of restructuring the innovation process are often very high for firms whose current innovation processes do not yield sufficient results. This is reflected not only in the profile of obstacles faced by enterprises (see above), but also in the fact that the share of innovative enterprises ¹⁰ has been declining since the turn of the century (see Figure 8). It is only in the last two survey periods that a counter-movement to this long-term trend is observed.

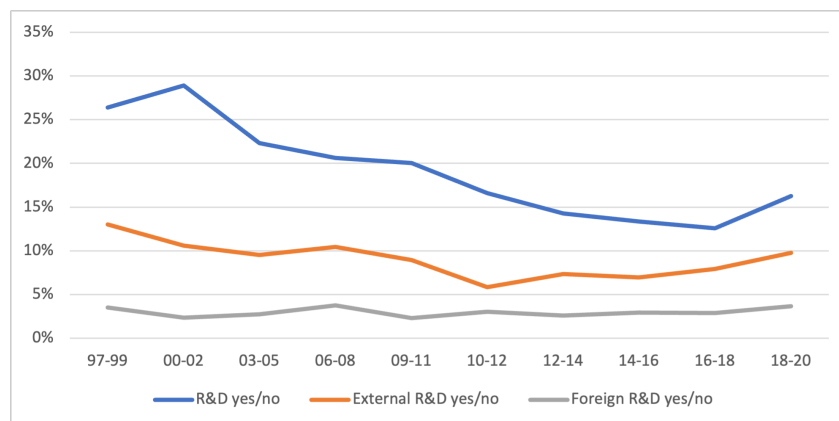


Figure 6: Share of R&D active firms. Source: KOF Innovation Surveys.

Despite the decline in the number of innovative companies, the average commercial success with innovative products has remained fairly constant over time (see Figure 9). However, the expenditures for generating innovations have increased significantly. The average share of turnover spent on R&D increased from around 1.4% in 1998 to over 3.5% in 2020. Furthermore, the share of private R&D expenditure as a percentage of GDP

¹⁰Innovation is defined according to the KOF innovation survey: Product/service innovations are new or significantly improved products or services whose components or basic characteristics (technical features, integrated software, usage characteristics, user-friendliness, availability, customer benefits, design, etc.) differ significantly from the products and services previously offered by a company.

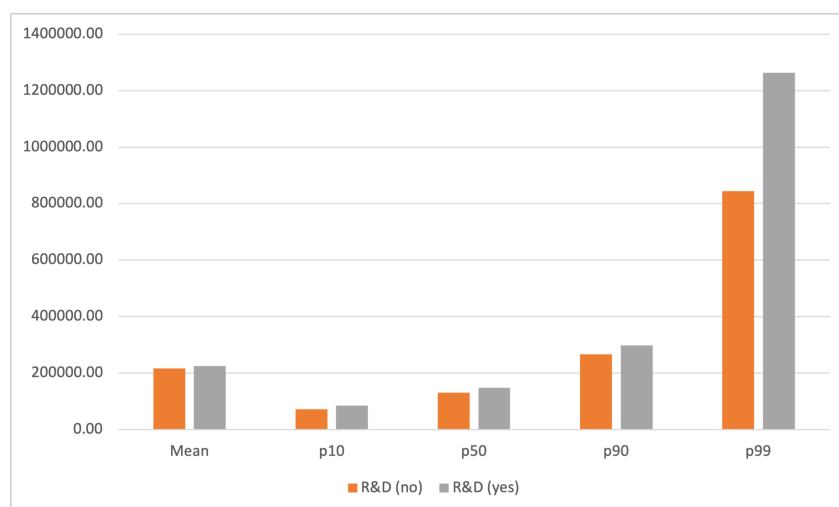


Figure 7: R&D yes/no: Value added per employee in CHF. Source: KOF Innovation Surveys.

Note: The figure shows the differences between R&D active and R&D inactive companies in terms of value added per employee at the mean, 10th percentile (p10), median (p50), 90th percentile (p90) and 99th percentile (p99) of the distribution of value added per employee.

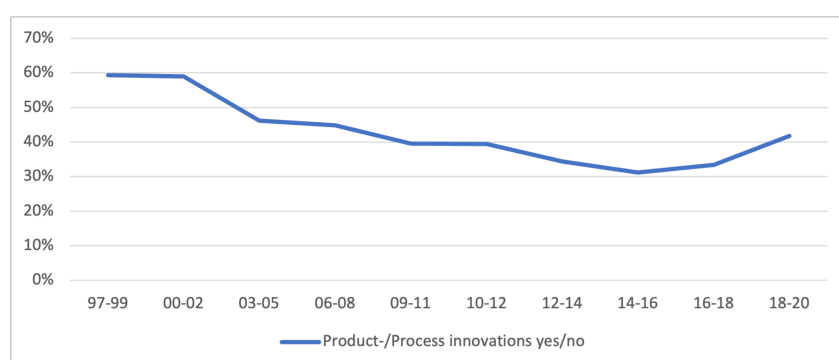


Figure 8: Share of innovative companies. Source: KOF Innovation Surveys.

increased from 1.67% to 2.29% between 2000 and 2021 (see Figure 10).

This demonstrates the increased efforts made by innovative companies to develop new products and services. It shows that the current innovation framework still provides the incentives to increase private investment in R&D in Switzerland, at least for some companies. The additional investment from these companies thereby outweighs the loss of investment from other companies that no longer carry out R&D. In other words, the decline in the number of firms active in R&D is more than offset by the increase in investment from the companies that remain being active in R&D.

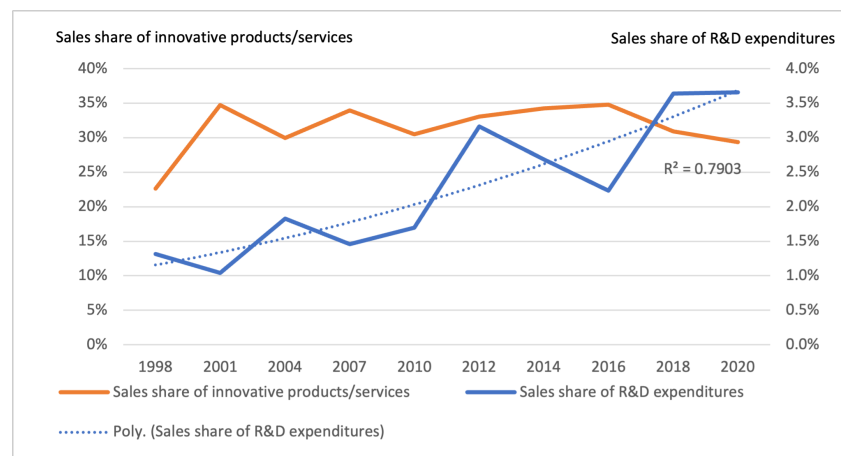


Figure 9: Commercial success: sales share of innovative products and services. Source: KOF Innovation Surveys.

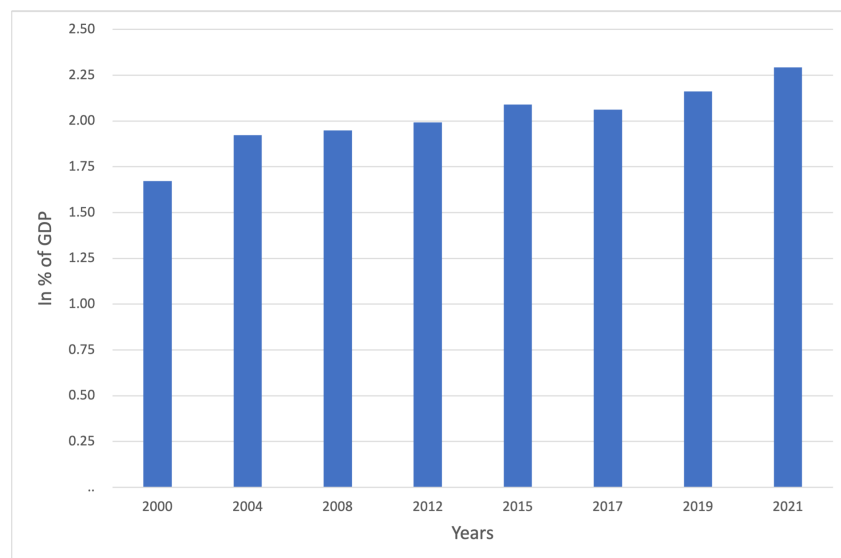


Figure 10: Switzerland: Gross domestic R&D expenditures of the private sector. Source: Swiss Federal Statistical Office, Indicator 20205.

Interestingly, there is a remarkable structural development behind this development. Figures 11 and Figure 12 show that the sales of products resulting from incremental innovations (products and services that are new to the company) have increased, while the sales

of products resulting from more radical innovations (products and services that are new to the market) have decreased. This means that the commercial success of new products and services developed through R&D has been increasingly based on incremental rather than radical innovations.

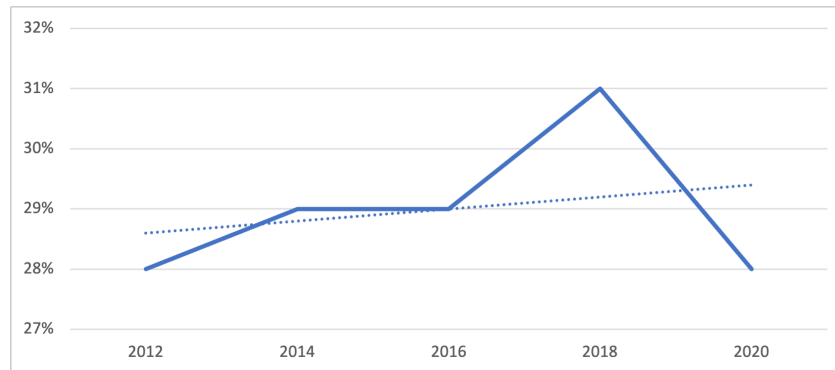


Figure 11: Sales of products resulting from incremental innovations (as % of total sales). Source: KOF Innovation Surveys.

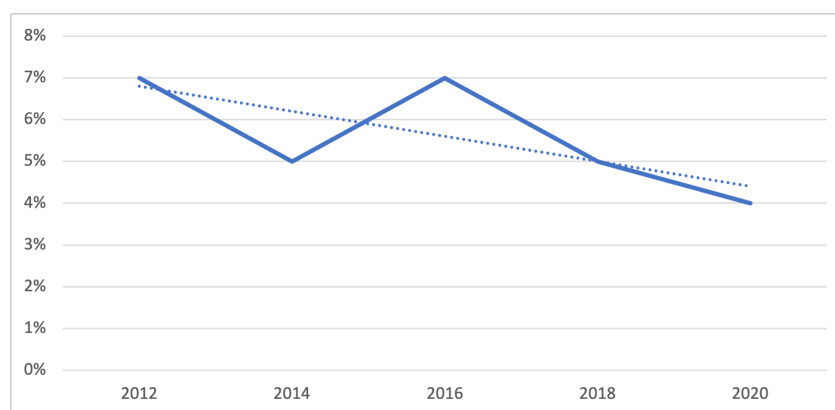


Figure 12: Sales of products resulting from radical innovations (as % of total sales). Source: KOF Innovation Surveys.

Tougher international competition for innovation: Figure 13 shows that the differences in innovation efforts across countries has increased.¹¹ In 2002, the difference between the country with the lowest and the highest share of firms active in R&D was 20 percentage points. In 2020, this difference amounts to about 35 percentage points. This indicates that companies in different countries pursue very different strategies to maintain their innovative strength. While in some countries the focus is on R&D-based innovation, in others non-R&D-based innovation activities are dominant.¹² This could also be related to governmental R&D policies in the respective countries and these countries' industrial

¹¹The EUROSTAT and KOF Innovation Surveys data captures enterprises with more than 10 employees, for selected sectors.

¹²We define “non-R&D-based innovation” as innovation that does not originate from dedicated or contracted R&D teams. For instance, learning-by-doing could lead to improvements in production processes.

structure. Typically, R&D-based innovations are of greater importance in countries with a large manufacturing sector than in more service-oriented economies. An unfavourable economic environment for R&D, such as a lack of skilled labour or a lack of technological infrastructure, may also lead to less R&D-based innovation.

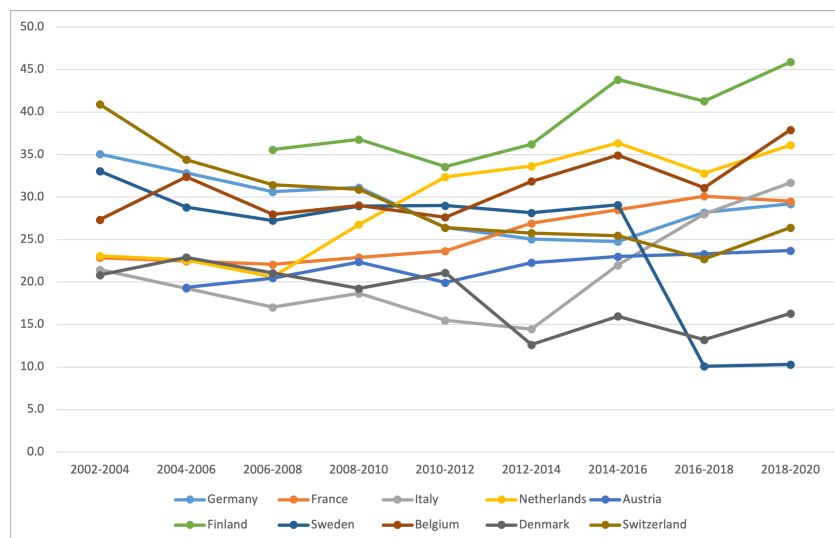


Figure 13: Share (in %) of firms active in R&D in international comparison. Source: EU-ROSTAT (Science, Technology, and Innovation database) and KOF Innovation Surveys.

For actual product innovations, as measured by the share of firms that have successfully developed new products, we see a different picture (Figure 14). While the differences in innovation success have been large in 2002, they have narrowed considerably over time, which points to increased competition in innovative activities. In 2002, the difference between Italy, the country with the lowest share, and Switzerland, the country with the highest share, was 35 percentage points. In 2020, this difference decreased to about 10 percentage points. If we take the results of Figures 13 and 14 together, we can see that while companies across countries seem to pursue very different strategies to generate innovations, they achieve rather similar levels of total innovation activity.

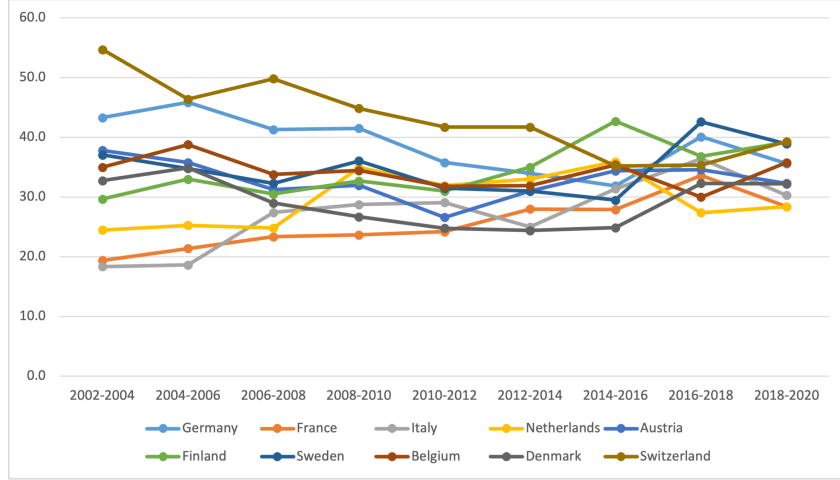


Figure 14: Share (in %) of firms with successful product innovations in international comparison. Source: EUROSTAT (Science, Technology, and Innovation database) and KOF Innovation Surveys.

4 Responses

Given the challenges outlined in subsection 3.1 and further detailed in subsection 3.2, we now ask how Switzerland could and should respond.

4.1 Joining the subsidy race?

Switzerland concentrates its efforts primarily on improving the economic conditions for innovation activities (excellent basic research, high quality of education, low corporate taxes) and on promoting knowledge and technology transfers between universities and the private sector. It has no tradition of large direct governmental support for innovation activities, such as R&D subsidies.¹³

As described above, the international environment for innovation activities has changed significantly in recent years, and many countries have added large-scale subsidy programs to their R&D strategies. In principle, support instruments such as direct R&D subsidies, R&D tax credits, and mission-oriented policies¹⁴ could also be used in Switzerland. The

¹³At the federal level, public support for innovation activities is mainly carried out by Innosuisse. Besides supporting knowledge and technology transfers in general, Innosuisse also runs other support schemes such as providing help for start-ups. In addition, the patent box, i.e., a low corporate tax regime used to incentivize R&D by taxing patent revenues differently from other commercial revenues, has been in place since 2020. Support for innovation activities is also provided at the cantonal level. Most cantons offer tax relief for R&D expenditures.

¹⁴The Swiss Science Council provides an overview of mission-oriented research and innovation in Switzerland and suggests that today's challenges require additional new emphases for mission-oriented research and innovation in Switzerland Swiss Science Council (2023). According to Azoulay et al. (2019), who studied the ARPA model, a mission-oriented program, it is important to recognise that "ARPA-type

question is whether Switzerland should indeed join this “subsidy race”.

Governmental subsidies tend to generate winners and losers among firms, and quantitative models suggest that even the gains from carefully designed industrial policies are quite small (Barthelme et al., 2021). However, the identification of the costs and benefits of industrial policy is quite complex (see, e.g., Rodrik et al., 2023). In terms of tax credits for R&D expenditures, several studies have examined how such measures can stimulate innovation activities—and found that, to some extent, they can be effective (Bloom et al. (2019) and OECD (2023b)).

Moreover, geopolitical considerations play a major role today, and their impact on how to use public support schemes for innovation activities is much harder to quantify. On the current debate of whether policy should promote international diversification or reshoring, we refer the interested reader to Grossman et al. (2023) and on open issues in the context of the WTO to Bown (2023). On whether it is indeed desirable to subsidize companies such as Intel with large sums to build a chip factory, see Kronberger Kreis (2023). For Switzerland, the conclusion is quite clear. Achieving self-sufficiency in key technologies is nearly impossible, and any attempt to do this in one industry would entail high costs for the other Swiss industries, as Switzerland is small and its structure of leading industries is well-developed.

Sometimes, subsidies might be useful to promote catch-up growth or to direct technological progress towards specific areas where market participants lack the private incentives to do R&D. Two examples are the market for new antibiotics to fight infections of currently resistant bacteria (see Böttcher and Gersbach, 2023) and the mitigation of climate change (see Acemoglu and Johnson, 2023). In general, however, subsidizing industries at the technological frontier would entail fighting over cutting-edge technologies about which the government has insufficient knowledge. As a consequence, public funds might be wasted (see also Economist, 2023). In sum, large-scale subsidy programs to promote the production of products and services in specific industries in Switzerland in order to secure supply would carry the substantial risk of being a waste of taxpayers’ money.

Still, it makes sense to ensure that the security of supply is guaranteed for a few key products and components. Switzerland should also revise its concept of security-of-supply (“Versorgungssicherheit”). A well-structured innovation system improves the resilience of the Swiss economy, as it allows for more flexible responses to shortages of particular products. Hence, maintaining and improving the Swiss Innovation System will also contribute to the security-of-supply.

organisations are not a substitute for other sources of R&D funding, but serve as a complementary part of a diverse innovation system”.

To sum up, from today’s perspective it is not advisable for Switzerland to join the subsidy race between the greater economic regions. Instead, Switzerland’s well-established and hitherto successful support strategies should be improved and, if necessary, expanded. Its focus should remain on a strong basic research sector and on knowledge and technology transfers between Swiss higher education institutions and the private sector. Moreover, there are potential responses to the OECD minimal tax should be considered, as we will do in the next subsections.

4.2 Knowledge and technology transfer

Knowledge and technology transfer (KTT) gives companies access to a skilled workforce, to advanced knowledge and technologies, and to the technological infrastructure of Swiss higher education and research institutions (HEIs). KTT has the potential to address most of the challenges mentioned above. For instance, innovation costs can be reduced by gaining access to the technological infrastructure of HEIs, collaborating with researchers or sponsoring PhD students to work on specific topics relevant to a company. KTT can increase the flexibility of companies to adapt to regulatory challenges or help them to take advantage of the opportunities that arise from them (e.g., in the area of environmental regulation or IT security). KTT also helps to increase the depth of innovation of new products and services by giving companies access to knowledge about cutting-edge technologies. This gives Swiss companies an international competitive advantage, shortens the payback period and, because it is cheaper, eases financial constraints, especially for SMEs. Most importantly, KTT has the potential to alleviate acute labour shortages in certain skill areas.

Many companies have already recognised the potential KTT has for their innovation efforts. According to the KOF KTT survey, around one-quarter of Swiss companies with more than 5 employees have contacts with Swiss HEIs for the purpose of KTT (Beck et al., 2020).¹⁵ Informal contacts and education- and mobility-related collaborations are regarded as very relevant for the transfer of knowledge and technology by around 50% of the relevant enterprises, while research-related collaborations (e.g., R&D cooperation and participation in R&D consortia with HEI) and shared infrastructures are regarded as very relevant by around 15% of the relevant enterprises (see Figure 15).¹⁶

¹⁵KTT is broadly defined. It includes not only R&D cooperation, co-patenting, and co-publishing with HEIs, but also the use of infrastructure, education-related forms of transfer such as internships for students, joint theses, and further training for employees. Spin-offs are not included.

¹⁶The data is based on all enterprises that were engaged in knowledge and technology transfer activities with scientific partners during three survey periods. Figure 15 shows the fraction of enterprises that reported at least one form of knowledge and technology transfer in the mentioned categories as highly relevant (values equal to or larger than 4 on a 5-point ordinal scale).

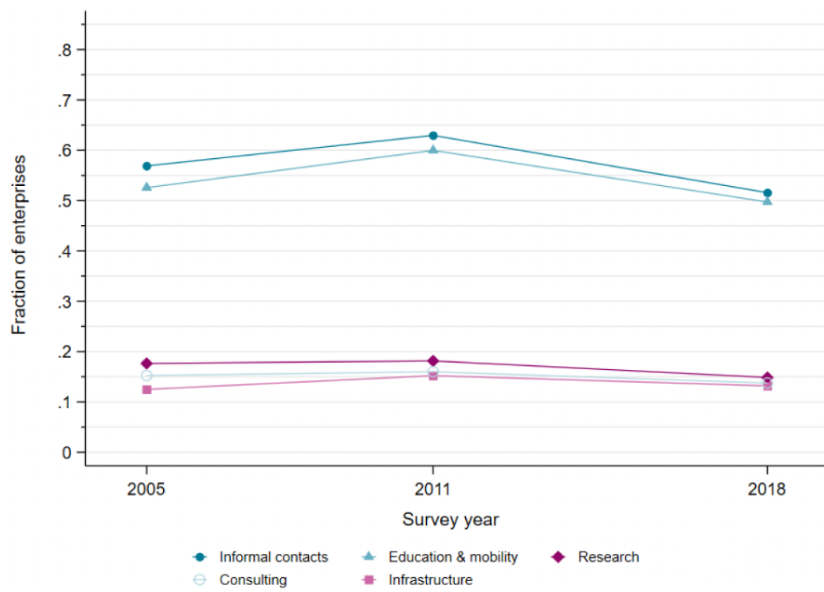


Figure 15: Forms of knowledge and technology transfer. Source: KOF-KTT surveys (2005, 2011, 2018)

Positive productivity effects from KTT require engaged forms of transfer (research- or education-related transfers) and the effects are stronger when firms also invest in R&D (see Arvanitis et al., 2008 and Beck et al., 2020). This suggests that firms need to have the capacity to understand the research activities of universities. A lack of this capacity can make KTT less effective or even ineffective for firms. Other issues related to KTT include a lack of interest in scientific projects or the perception that the company's R&D issues are of no interest to the scientific partners. There are also cost and risk factors that inhibit KTT. Most importantly, many companies lack the financial resources to engage in or intensify KTT. Enterprises also face problems in the interaction with universities. A lack of available information about research activities at universities, difficulties in finding suitable contacts, lack of entrepreneurial thinking at universities, no guarantee of confidentiality or exclusivity and different priorities all contribute to the fact that even enterprises active in R&D often do not engage in KTT (see Beck et al. (2020)).

While many of these obstacles are inherent to KTT, both sides—the firms and the HEIs—can work together to realize the high potential of KTT. Specific measures to do so will be outlined in the next subsection.

4.3 Switzerland as an attractive location for innovation

The OECD/G20 minimum tax could become a challenge for the attractiveness of Switzerland as an innovation and business location.¹⁷ Currently, Switzerland is attractive to many foreign companies. Measures to maintain and improve this level of attractiveness could therefore be part of an appropriate response to the potential disadvantages Switzerland faces from the introduction of a minimum tax. More particularly, one could start with expanding the existing policy instruments to support innovation.

We consider four possible ways to react. First, technology transfers between universities and the private sector are a strength of the Swiss innovation system that could be expanded. This is because both the universities of applied sciences—one of the most important players in knowledge transfer along with the ETH—, and the cantonal universities are largely at the responsibility of the cantons. KTT capacities could be expanded based on the regional impact of the OECD minimum tax.

Second, a flexible way of promoting innovation by knowledge transfer is through so-called “Coasean” institutions, such as “Inspire” in Switzerland (see Foray and Woerter, 2020). These types of institutions pool sector-specific research interests and create the institutional framework for effective technology transfers between the participating companies and universities. This is of particular benefit to smaller companies, which often lack the resources to approach universities directly. Since many Swiss branches of foreign companies subject to the OECD minimum tax are rather small, further developing such institutions could also help to maintain the attractiveness of Switzerland as a business location¹⁸.

Third, as the knowledge absorption capacity of a company is essential for successful knowledge transfers and as this is closely linked to a company’s internal innovation efforts, it seems reasonable to strengthen this capacity through an expanded R&D tax credit program at cantonal level that is in line with OECD rules. As discussed in 4.1, tax credits for R&D expenditures indeed display some degree of effectiveness.¹⁹ This will help companies to expand their internal R&D. For cantons with a strong innovation ecosystem or cantons who want to further develop their ecosystem, R&D tax credits

¹⁷According to Economiesuisse (2023), about 200 Swiss companies and 2,000 foreign companies with branches in Switzerland will be affected by the minimum tax. As these companies are not evenly distributed across Switzerland, some cantons will be more affected than others. Nevertheless, the associated economic effects are expected to be felt in all cantons.

¹⁸Switzerland’s connection to the European Research Area, for example through Horizon Europe, is important for knowledge transfer with this region and for Switzerland’s attractiveness as a location for innovation and research. However, it is beyond the scope of this study to address these issues.

¹⁹The OECD has defined special conditions for R&D tax credits (“Qualified Refundable Tax Credits”). For example, the tax credit may not be conditional on a company making a profit. The tax credit must be paid out in case of prolonged losses (see Economiesuisse, 2023).

could be expanded, of course subject to budget constraints.

Fourth, Innosuisse is the main agency that promotes innovation activity in Switzerland. It actively supports the knowledge and technology transfer between universities and the private sector. In doing so, public funds are provided only to the university partner. The private project partner must cover at least 50% of the project costs. Making this private share more flexible could increase the attractiveness of this funding instrument and thereby further promote innovation activities in Switzerland.

An increasing demand for R&D activities will also increase the demand for scientists. The number of scientists must therefore increase if the measures to promote R&D are not to be reflected solely in higher salaries for R&D personnel. Therefore, complementary measures to increase the supply of well-qualified graduates are needed, especially in the fields of technology, engineering and mathematics. Only with such measures will it be possible to meet the medium-term increase in demand. Migration is another factor that could help alleviate the problem. Many studies show that the immigration of highly skilled workers increases a country's innovative capacity both directly, through their innovative performance (see, e.g., Kerr and Lincoln, 2010) and indirectly, through positive spillovers to the rest of the economy (Bernstein et al., 2022; Hunt and Gauthier-Loiselle, 2010). A sufficient supply of highly qualified labour and simple bureaucratic procedures for hiring foreign R&D workers would certainly increase the attractiveness of Switzerland as a location for innovative businesses.

A word of caution is in order. Identifying specific measures and tailoring them to specific cantons would require a detailed analysis of the companies affected, which we cannot undertake here. Such an analysis would have to be preceded by a survey of the companies affected in order to identify their motivations to choose Switzerland as a business location, as well as by an assessment of Switzerland's advantages and disadvantages for individual types of companies.

4.4 Long-term Viability of public innovation support as an infrastructure

One can view the existing publicly supported institutions that perform basic and applied research to promote innovation in the private sector as a mix of tangible and intangible infrastructure. The tangible part is the physical infrastructure consisting of buildings, labs, machines/workstations and materials. The intangible part consists of the knowledge and experience that has been accumulated as human capital.

Basic research, viewed as infrastructure, differs from other physical infrastructure investments like roads, bridges, and public transport systems, which can also improve the productivity of the private sector, by two characteristics. First, it generates knowledge that enables the private sector to invent new products and processes. Second, it accumulates knowledge by building on previous knowledge. The newly generated knowledge produced by a new cohort of scientists depends on the existing knowledge generated by previous scientists.²⁰

Hence, public innovation support as an infrastructure for the Swiss economy requires continuous maintenance and improvements to meet the constantly changing requirements. In view of the new challenges we are facing, its long-term viability may even be increased. Hence, as Switzerland's approach in other areas, such as the transport sector infrastructure, for instance, maintaining the infrastructure through steady funding is essential. Otherwise, as is well-documented for Germany in the case of physical infrastructure, for instance (see Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Energie (2020)), serious economic and budgetary problems will arise down the road.

5 Conclusion

The Swiss Innovation System is challenged in multiple ways. Our brief assessment suggests that maintaining and strengthening it is most likely the best course of action for Switzerland. Improvements on knowledge and technology transfers should be an additional focus. Expanding existing instruments at Innosuisse or tax credits for R&D expenditures at the cantonal level might further promote innovation efforts in the private sector and could provide a response to international challenges such as the OECD minimum tax. It is equally important that Switzerland's general economic conditions such as entrepreneurship of residents in Switzerland, an open access to international markets for goods and services, and the free movement of researchers are maintained—or even enhanced, whenever possible.

²⁰The knowledge generated by basic research also benefits from applied research in the private sector, as private R&D activities uncover new problems to be solved by basic research, for instance.

References

- Acemoglu, D. and Johnson, S. (2023). *Power and Progress: Our Thousand-Year Struggle Over Technology and Prosperity*. Hachette, New York, NY.
- Aghion, P. and Howitt, P. (1996). Research and Development in the Growth Process. *Journal of Economic Growth*, 1:49–73.
- Akcigit, U., Hanley, D., and Serrano-Velarde, N. (2021). Back to basics: Basic research spillovers, innovation policy, and growth. *Review of Economic Studies*, 88(1):1–43.
- Arvanitis, S., Seliger, F., and Woerter, M. (2023). In search of markets and technology: the role of cross-border knowledge for domestic productivity. *Industrial and Corporate Change*, 32(5):1135–1162.
- Arvanitis, S., Sydow, N., and Woerter, M. (2008). Do specific forms of university-industry knowledge transfer have different impacts on the performance of private enterprises? An empirical analysis based on Swiss firm data. *Journal of Technology Transfer*, 33(5):504–533.
- Azoulay, P., Fuchs, E., Goldstein, A. P., and Kearney, M. (2019). Funding breakthrough research: Promises and challenges of the “ARPA model”. *Innovation Policy and the Economy*, 19(1):69–96.
- Barjak, F., Foray, D., and Woerter, M. (2023). Mastering multiple complexities – A rising challenge for Swiss innovation models. *KOF Studies*, 173.
- Barthelme, D., Costinot, A., Donalson, D., and Rodriguez-Clare, A. (2021). The textbook case for industrial policy: Theory meets data. *University of California Berkeley Working Paper*.
- Beck, M., Hulfeld, F., Spescha, A., and Wörter, M. (2020). Analysis of knowledge and technology transfer in Switzerland—the perspective of the enterprises: Study elaborated as part of the report Research and Innovation in Switzerland 2020 Part C, Study 4. Technical report.
- Bernstein, S., Diamond, R., Jiranaphawiboon, A., McQuade, T., and Pousada, B. (2022). The contribution of high-skilled immigrants to innovation in the united states. Technical report, National Bureau of Economic Research.
- Bloom, N., Van Reenen, J., and Williams, H. (2019). A Toolkit for Policies to Promote Innovation. *Journal of Economic Perspectives*, 33(3):163–184.
- Bown, C. (2023). Modern Industrial Policy and the WTO. *PIIE Peterson Institute for International Economics Working Paper*, 23-15.

- Böttcher, L. and Gersbach, H. (2023). Neue Anreize für die Erforschung und Entwicklung von Antibiotika. *KOF Bulletin*, 175:13–16.
- Cozzi, G. and Galli, S. (2009). Science-Based R&D in Schumpeterian Growth. *Scottish Journal of Political Economy*, 56(4):474–491.
- Cozzi, G. and Galli, S. (2017). Should the Government Protect Its Basic Research? *Economics Letters*, 157(C):122–124.
- Economiesuisse (2023). OECD-Mindeststeuer - Steuereinnahmen sichern, Wettbewerbsfähigkeit erhalten, Dossierpolitik 3/23, economiesuisse, Zürich. Technical report, Dossierpolitik 3/23, economiesuisse, Zürich.
- Economist (2023). The world is in the grip of a manufacturing delusion: How to waste trillions of dollars. July 15th 2023.
- Foray, D. and Woerter, M. (2020). The formation of Coasean institutions to provide university knowledge for innovation: a case study and econometric evidence for Switzerland. *Journal of Technology Transfer*.
- FSO (Federal Statistical Office) (2023). Forschung und Entwicklung (F&E)-Aufwendungen der Privatwirtschaft. Technical report, FSO, Neuchâtel.
- Gersbach, H., Maunoir, P., and Sorger, G. (2023a). Optimal Hierarchical Growth. *mimeo*.
- Gersbach, H., Schetter, U., and Schmassmann, S. (2023b). From local to global: A unified theory of public basic research. *European Economic Review*, forthcoming.
- Gersbach, H., Schetter, U., and Schneider, M. T. (2021). Macroeconomic rationales for public investments in science. *Economic Inquiry*, 59(2):575–599.
- Gersbach, H. and Schneider, M. (2015). On the optimal supply of basic research. *Journal of Monetary Economics*, 75(C):123–137.
- Gersbach, H., Schneider, M. T., and Schneller, O. (2013). Basic research, openness, and convergence. *Journal of Economic Growth*, 18(1):33–68.
- Gersbach, H., Sorger, G., and Amon, C. (2018). Hierarchical Growth: Basic and Applied Research. *Journal of Economic Dynamics and Control*, 90:434–459.
- Grossman, G., Helpman, E., and Lhuillier, H. (2023). Supply Chain Resilience: Should Policy Promote International Diversification or Reshoring? *Journal of Political Economy*, forthcoming.
- Hunt, J. and Gauthier-Loiselle, M. (2010). How much does immigration boost innovation? *American Economic Journal: Macroeconomics*, 2(2):31–56.

- Jones, B. F. and Summers, L. H. (2022). A calculation of the social returns to innovation. In Goolsbee, A. and Jones, B. F., editors, *Innovation and Public Policy*. Chicago University Press. <https://doi.org/10.1787/72df5066-en>.
- Kerr, W. R. and Lincoln, W. F. (2010). The supply side of innovation: H-1b visa reforms and us ethnic invention. *Journal of Labor Economics*, 28(3):473–508.
- Kronberger Kreis (2023). *Wirtschafts- und Industriestandort Deutschland in Gefahr?* Stiftung Marktwirtschaft.
- OECD (2023a). *Global Minimum Corporate Tax Rate*. OECD. www.oecd.org.
- OECD (2023b). *The Impact of R&D Tax Incentives: Results from the OECD microBeRD+ Project*. OECD. www.oecd.org.
- Rodrik, D., Juhász, R., and Lane, N. (2023). Economists reconsider industrial policy. *Project Syndicate*, August 4 2023.
- Spescha, A. and Wörter, M. (2022). Innovation und Digitalisierung in der Schweizer Privatwirtschaft-Ergebnisse der Innovationserhebung 2020. Technical Report November, Staatssekretariat für Bildung, Forschung, und Innovation (SBFI), ETH Zürich, KOF Swiss Economic Institute, Zürich.
- Spinesi, L. (2013). Academic and Industrial R&D: Are they always Complementary? A Theoretical Approach. *Oxford Economic Papers*, 65(1):147–172.
- Swiss Science Council (2023). Mission-oriented Research and Innovation in Switzerland. Technical report, Swiss Science Council,, SSC Report 1/ 2023, Bern.
- Wissenschaftlicher Beirat beim Bundesministerium für Wirtschaft und Energie (2020). *Öffentliche Infrastruktur in Deutschland: Probleme und Reformbedarf*. Bundesministerium für Wirtschaft und Energie (BMWi), Berlin.
- World Intellectual Property Organization (WIPO) (2022). Global Innovation Index 2022: What is the future of innovation-driven growth? Technical Report 8.5.2017, WIPO, Geneva: WIPO. DOI 10.34667/tind.46596.