Intellectual Property Protection and Innovation in Switzerland

Study elaborated as part of the report
"Research and Innovation in Switzerland 2020"
Part C, Study 6

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1. Executive Summary

This Report discusses the intellectual property (IP) system in Switzerland, and how it sustains innovation. It focuses on one type of IP, namely patents, and considers all types of economic actors in Switzerland, notably multinational enterprises (MNEs), small and medium-sized enterprises (SMEs), startups and universities. The Report takes a policy perspective. Patent policy is a key component of innovation policy, which is concerned with the set of government interventions that help economic actors create, develop, transfer, and commercialize innovations. As understood in this Report, innovation is a new or improved product or process that differs significantly from the unit's previous products or processes and that has been made available to potential users or brought into use by the unit. There are many different ways in which innovation policy can encourage innovative activities, including, e.g., research & development (R&D) grants and subsidies. Other policy areas than innovation policy are equally important for sustaining innovation, e.g. education policy.

This Report gathers insights from three main sources. First, it surveys the law and economic literatures on intellectual property. Second, it relies on empirical evidence on the state of patenting in Switzerland. Third, it collects the views of selected local economic actors on the Swiss patent system. Some of the key findings are as follows.

The literature review has highlighted that in core fields such as pharmaceuticals, a strong case can be made that the patent system encourages innovation and ultimately promotes social welfare. However, one should always keep in mind that the beneficial effects of the patent system in one industry do not necessarily translate to other industries. Furthermore, some well-documented failures of the patent system are the result of abusive patenting strategies by some actors. The use of patents evolves with technologies, which calls for continuously adapting and fine-tuning the patent system to limit the effect of such strategies.

The quantitative analysis provides three main insights. First, patenting is overall a rare event. It is low at the extensive margin (few firms file for patents), but high at the intensive margin (when firms file for patents, they usually file many). Second, the R&D process of Swiss companies is highly globalized, and many companies have developed their inventions abroad. Overall, a quarter of inventions by Swiss MNEs are made in Switzerland (25.28 percent) and the European Union (27.11 percent) each. Two-thirds of inventions are made in OECD countries (67.80 percent), which includes Switzerland and the most advanced European countries. Third, as a result of the globalization of R&D, few inventions made in Switzerland are actually filed at the Swiss patent office as priority filings. Swiss applicants often file patents at the European Patent Office (EPO), to later validate their patents in Switzerland.

In general, our interviewees have a favorable opinion of the patent system, even though we have heard common complaints related to its cost, complexity and slow speed. Interview partners have mixed opinions on whether the Swiss Federal Intellectual Property Office (IPI) should start offering substantive examination. Other aspects of IP law such as a research exemption matter for sustaining innovation. Interview partners seemed to believe that the Swiss patent system strikes the right balance. Finally, the establishment of the Swiss Federal Patent Court was seen as a welcome development.

2. Scope of the Report

Overview

This Report discusses the IP system in Switzerland and how it sustains innovation. It focuses on one type of IP, namely patents, and considers all types of economic actors in Switzerland, notably multinational enterprises (MNEs), small and medium-sized enterprises (SMEs), startups and universities. The Swiss IP system must be considered in its specific environment in order to fully apprehend it. Switzerland is a small open economy in the heart of Europe, and the Report places the discussion in the context of the European and global patent system when relevant. However, the Report does not make any claims about the quality of the European patent system. While patent rights are territorial in nature, the decision to seek patent protection in Switzerland is often taken jointly with the decision to seek protection in other European countries. Moreover, although the Swiss patent system has some unique features, the underlying tradeoffs innovation policy faces when designing a patent system are often universal in nature.

A patent is an IP right for a technical invention. It allows inventors to prevent others from commercially making, using, selling, importing, or distributing a patented invention without authorization. Patent protection is usually granted for a period of up to twenty years[1] for inventions that are novel, inventive and industrially applicable.[2] They are central to the appropriation strategy of innovative firms, although they are not the only way to appropriate revenues from innovation.

Box 1. Invention and Innovation

While patents are important for sustaining innovation, they do not equate innovations. Patents are used to protect inventions, which include novel devices, methods, compositions or processes. By contrast, innovations can be seen as inventions put into practice.

More formally, the authoritative Oslo Manual defines an innovation as “a new or improved product or process (or combination thereof) that differs significantly from the unit’s previous products or processes and that has been made available to potential users (product) or brought into use by the unit” (OECD/Eurostat, 2018).

Patent protection is only one type of IP right. Other common IP rights include trademarks, designs, copyrights and geographic indications, but also plant variety rights and, in some countries, utility models (see Section 6 for definitions). While all these IP

[1] Some inventions can be protected for more than 20 years. In Europe, for instance, supplementary protection certificates (SPCs) extend the duration of certain rights associated with patents for human or veterinary medicaments and plant protection products.

[2] These are the three basic requirements for a grant, which are checked by patent offices during the patent examination process. The novelty requirement imposes that the invention must be new to the world to deserve patent protection. The inventiveness requirement imposes that the invention must exceed a certain inventive step to deserve patent protection. Thus, a patent application for an invention will be rejected during examination if the invention has been described elsewhere or is deemed too trivial. In practice, countries apply these requirements more or less strictly. Switzerland offers no substantive examination (inventiveness and novelty), as discussed further in Box 9.

rights are important for firms to appropriate the revenues from their innovations, patents usually attract most of the attention in the popular press as well as in the scholarly and policy debates. There are various reasons for the prominence of patents, and the Report discusses some of these reasons throughout.

The present Report takes a policy perspective. Patent policy must be understood as a key component of innovation policy, which we define in broad terms as the interaction between public policy and the innovation process. More precisely, innovation policy is concerned with the set of government interventions that help economic actors create, develop, transfer, and commercialize innovation. In addition to the patent system, an innovation policy includes, but is not limited to, components such as R&D grants and subsidies, public provision of basic research, entrepreneurship support, and the tax system. To the extent that innovation has wide-ranging sources and implications, other policy areas also have a direct effect on innovation. This is typically the case for education policy (vocational education and tertiary education), which trains the workforce necessary to fuel the innovation engine, as well as labor law.

It is important to bear the following points in mind when reading this Report. First, patents are used to protect technical inventions. Not all inventions turn into profitable innovations, and not all innovations rely on patented inventions. Not all innovative firms rely on patents, and patenting firms are not all successful innovators. Second, because patent policy is only one component of the broader policy environment for innovation, this Report does not claim that patent policy is the only—nor even the most prominent—tool to support innovation.

Approach

In order to write this Report, we have surveyed the law and economic literatures on intellectual property (peer-reviewed and grey), and we have interviewed local economic actors to gather their view on the Swiss patent system. We have also worked in close collaboration with the IPI to produce hard evidence on the state of patenting in Switzerland.

Regarding the literature review, we have searched for peer-reviewed articles dealing with a broad range of topics directly related to IP. These topics include, but are not limited to: the role of IP for innovative firms; IP and firm productivity; macroeconomic impact of IP; evidence on knowledge spillovers across regions and across industries; IP and business model innovation; one-size-fits-all patent system; evidence on patent effectiveness; petty patents; the various roles of patents and industry specificities; patents as incentive to invest in innovation; evidence on motives to patent; detrimental effects of patents, e.g., in cumulative or complex technologies; IP and open innovation; tradeoff between patenting and secrecy; and evidence on the Swiss patent system.

The identified articles were then reviewed and assessed for quality, also considering the academic journals in which they were published and the number of citations they received. They were then compared with the bibliography of some recent literature review articles in order to identify gaps. Overall, we have reviewed about 120 articles. Not all these articles and topics are covered in the final report, but they have all fed our thoughts.

As far as the interviews are concerned, we interviewed fourteen professionals from companies and universities located in Switzerland (for a list of interview partners, see Appendix A). We conducted semi-structured interviews, meaning that we allowed ourselves to depart from the list of questions we had prepared as the conversation evolved. We designed the interviews as background conversations to enable our interview partners to freely and openly share their views. Thereby, our interviews may shed some light on selected aspects of the Swiss IP system. But as we conducted interviews with a limited number of IP professionals, we do not claim that our interviews provide a representative view of the Swiss industry on the system. The views we have collected are blended into Sections 3 and 4 of this Report, and no individual quotes are attributed to specific interviewees.

Structure of the Report

The Report is organized as follows. Section 3 reviews the literature on the role of patents in fostering innovation. Section 4 presents quantitative evidence on the state of patenting in Switzerland. Both sections also present views we gathered from the interviews we conducted. Section 5 provides a forward-looking perspective on the Swiss patent system.

3. Evidence on the Role of Patents in Fostering Innovation

At first sight, the story behind patent protection seems straightforward. Inventors receive a patent in order to monetize their inventions, thereby contributing to technological progress in society. However, as this section will demonstrate, both theory and empirical evidence lead to a more nuanced picture of the relationship between patent protection and innovation.

Knowledge as a Public Good

Intellectual property rights—mainly patents, copyrights, trademarks, designs rights, but also geographic indications, plant variety rights and, in some countries, utility models—lie at the heart of a modern innovation policy. In the areas of patent and copyright law, the classic theoretical justification is that these rights exist in order to overcome a public goods problem (Landes and Posner 2003: 12–16).[3] According to this argument, knowledge is a public good. As other public goods, knowledge is non-rival in use and non-exclusive in consumption.

Box 2. Public Goods in Economics

Public goods differ from private goods in that

(1) individuals cannot be effectively excluded from their use (non-excludability); and
(2) their consumption by one individual does not reduce the availability of the good to others (non-rivalry).

Classic examples of public goods include lighthouses, national security, streets, clean air and the environment, but also knowledge. An example may illustrate the difference between private and public goods. If someone holds an apple in his hand, he can prevent others from taking the apple by his physical control over the apple (excludability) and, once he has eaten it, the apple is gone (rivalry). If someone has some information in a world without intellectual property rights, he cannot effectively exclude others from taking the information (non-excludability), and, by using the information, the information does not become less valuable to others (non-rivalry). In practice, ideas and inventions are largely non-rival: the economic value that one can extract from them decreases with the number of users, but to a significantly lower extent than for private goods.

An entire field of economics has pointed out that public goods can lead to market failures because market actors do not have sufficient incentives to produce such goods in a market economy (Samuelson 1954; Coase 1974). This leads to a "free rider" problem in public goods: consumers may benefit from public goods without contributing sufficiently to their production, thereby not providing sufficient incentives to producers to create these goods in the first place.

[3] As this Report focuses on patents, it does not cover theoretical and empirical insights concerning other intellectual property rights.

Box 3. Market Failures in Economics

A market failure occurs when the competitive market does not lead to an allocation of resources that is efficient from a social welfare viewpoint. Typical examples of market failures include public goods, monopolies, information asymmetries, and externalities. Market failures are a prime reason for government to intervene by ensuring that private incentives are aligned with what is desirable from a social welfare perspective.

The market failure resulting from public goods can be a reason for direct government intervention: The state may operate lighthouses, provide military defense, or invest in universities to produce knowledge. It may, however, also rely on interventions that do not produce the public good themselves but restore the incentives for others to produce such goods. This is what most countries in the world have been doing in the case of knowledge production: by providing exclusion rights such as patents, they turn knowledge from a non-excludable information into an excludable resource. Inventors can rely on a patent to exclude competitors from using their invention without paying a licensee fee. From an ex ante perspective, the anticipated revenue stream from the licensed patent generates incentives for the inventor to come up with the invention in the first place (Landes and Posner 2003: 12–16).

From an economic perspective, the patent system is not the only mechanism to address the market failure associated with knowledge production. R&D grants and subsidies also lower the cost of knowledge production borne by private actors, thereby making it a more attractive activity. Innovation prizes have also been found to be an effective mechanism for encouraging innovation (Wright 1983, Brunt et al. 2012).

Conversely, providing incentives to inventors is not the only policy goal of the patent system. Every patent system involves a bargain between inventors and society. Inventors receive a right to exclude that is limited in scope and time. In turn, they have to reveal their invention to the public through the patent document, thereby not only enabling society to benefit from the patented invention after the patent expires, but also enabling other inventors to learn from and build upon the invention while the patent is still in force. Thereby, an important theoretical component of the patent system is to enable spillovers among inventors and to facilitate cumulative innovation processes where inventors build upon each other (Scotchmer 1991).

So, is Patent Protection Critical for Innovation?

While the justification for patent protection based on public goods theory seems inherently coherent and convincing, determining its practical importance for innovation policy is more challenging for at least four reasons:

1. Individual actors and companies usually do not only rely on the patent system, but also on other means that provide incentives for innovation;
2. Companies that use the patent system do so for a variety of reasons, not all of which are related to the incentive rationale of the patent system;
3. Some sectors do not rely on IP protection as an exclusionary tool, but rather share information openly;
4. The currently available empirical evidence on the causal link between patent protection and innovation produces mixed results.

Each of these reasons will be elaborated in the following. *First*, concerning substitutes to the patent system, providing exclusion rights such as patents is not the only way the state can provide incentives to inventors. As explained briefly above, other tools include direct subsidies, prizes and awards to inventors, as well as the special treatment of IP rights in the tax system (Chatagny et al. 2017). One of our interview partners pointed out that an environment that is supportive for research (e.g., in terms of research exemption) is as important for sustaining innovation as the patentability requirements. Another interview partner noted that Switzerland could think about limiting intellectual property protection strategically in order to become a technology hub in certain areas (e.g., platforms enabled by machine learning). Yet another interviewee praised the innovation system in Switzerland for its heterogeneity. Unlike in other smaller European countries, e.g., patent ownership is not restricted to a small number of large firms, but is widely dispersed among small and medium enterprises as well. Several interview partners explained that their company's patenting and patent transfer strategy is heavily influenced by tax considerations. In this context, it is clear that current discussions related to the generalization of a patent box regime have the potential to have a large impact on the incentives to invest in innovation (and for foreign firms to locate inventive activities in Switzerland). Finally, the availability of a qualified workforce in Switzerland was sometimes seen as a strategic asset for appropriating the revenues from innovation. For instance, the operation of complex production networks, the production of sophisticated devices and the focus on high-end products are facilitated by employing a high-quality work-force and are critical to maintaining competitive advantage. A comprehensive innovation policy must not only design these individual systems in a most effective way, but must also consider that these systems will interact, sometimes producing unintended strategic responses by market participants (Gallini & Scotchmer 2001; Hemel and Ouellette 2013 & 2019).

In addition, numerous surveys that have been conducted with innovative companies since the 1980s around the world indicate the limited importance of the patent system in many industries. It turns out that, on an average across industries, patent protection is not the most important tool for companies to appropriate inventions. Rather, keeping inventions secret and being faster than competitors (lead time) are the most important mechanisms according to surveyed firms (for an overview, see Hall et al. 2014: 380–386). Table 1 reports the main findings of the most well-known surveys on the topic.

Table 1. Surveys on the Importance of Various Appropriation Mechanisms

Survey		Levin et al. (1987)	Brouwer and Kleinknecht (1999)	Arundel (2001)	Cohen et al. (2000)	Blind et al. (2006)	Arundel et al. (1995); Arundel and Kabla (1998)	Cohen et al. (2002)
Period covered		1981-1983	1990-1992	1990-1992	1994	2002	1990-1992	1994
Country		U.S.	NL	DE, LU, NL, BE, DK, IE, NO	U.S.	DE	UK, DE, IT, NL, BE, ES, DK, FR	U.S., JP
Coverage		650 lines of business, R&D-doing mfg. publicly traded firms	1,000–2,000 mfg. firms	2,849 R&D doing mfg. firms	1,165 large R&D-doing mfg. firms	522 firms with ≥ 3 EPO patent applications	414 PACE + 190 French large R&D-doing mfg. firms	593 large R&D-doing mfg. firms
High importance	Patents	Prod.: 4.3* Proc.: 3.5*	Prod.: 25% Proc.: 18%	Prod.: 11% Proc.: 7%	Prod.: 35% Proc.: 23%	79%	Prod.: 67% Proc.: 46%	Prod.: JP 38%; US 36% Proc.: JP 25%, US 24%
	Secrecy	Prod.: 3.6* Proc.: 4.3*	Prod.: 33% Proc.: 41%	Prod.: 17% Proc.: 20%	Prod.: 51% Proc.: 51%	58%	Prod.: 54% Proc.: 65%	Prod.: JP 26%; US 51% Proc.: JP 29%, US 53%
	Lead time	Prod.: 5.4* Proc.: 5.1*	Prod.: 57% Prod.: 56%	Prod.: 54% Proc.: 47%	Prod.: 53% Prod.: 38%	88%	Prod.: 67% Prod.: 46%	Prod.: JP 41%; US 52% Proc.: JP 28%, US 38%
Sector	Patents	High: pharma Low: pulp, paper	High: pharma/ chemicals/petroleum Low: basic metals	n.a.	High: medical equipment, pharma Low: printing/ publishing	High: rubber & plastic, biotech Low: construction/mining	High: pharma Low: prod.: utilities; proc.: electrical equip.	n.a.
	Secrecy	n.a.	n.a.	n.a.	High: misc. chemicals Low: printing/ publishing	n.a.	High: Food Low: prod.: fab. metals; proc.: utilities	n.a.
Percent patenting companies		n.a.	2.7%	n.a.	Prod.: 49% Proc.: 31%	100%	86%	Prod.: JP 62%; US 54% Proc.: JP 42%, US 32%

Notes: CH: Switzerland, DE: Germany, LU: Luxemburg, NL: Netherlands, BE: Belgium, DK: Denmark, IE: Ireland, ES: Spain, IT: Italy, NO: Norway, CA: Canada, FR: France, JP: Japan; mfg.: manufacturing; prod.: product innovation; proc.: process innovation; * mean scores (range: 1 = not at all effective, 7 = very effective).

Source: Hall et al. (2014: 381).

Once one distinguishes between industries, important differences become apparent, however. Patent protection plays a central role certainly in the pharmaceutical and chemical industry, and sometimes in the medical instrument and parts of the machinery industry (Hall et al. 2014: 382, 383, 386, 418). Expected premiums generated by patents are highest in medical instruments, biotech, and drugs, followed by computers, machinery, and industrial chemicals (Arora et al. 2008). Our interviews confirmed that patents are of crucial importance in the life science sector, not only for big pharmaceutical companies, but also for start-ups. It is difficult to launch a successful start-up company in this sector without a good patent. Nevertheless, it is important to note that, while surveys and interviews provide crucial insights on how important companies consider the patent system, they are unable to provide a definite answer to assessing the social benefits of the patent system.

The *second* reason why it is challenging to determine the practical importance of patent protection for innovation policy concerns the motives to patent. Companies do not only file patents in order to protect themselves against imitation. Our interviews confirmed that the motivations to seek patent protection are manifold, that companies often use sophisticated patenting strategies, and that these strategies vary across industries. Companies may seek patent protection for a variety of reasons, including:

- to build a defense against potential patent lawsuits;
- to prepare an arsenal of patents for negotiations or cross-licensing;
- to preempt patenting by competitors;
- to later sell a patent; or
- to prepare entrance into a foreign market.

Furthermore, small firms in particular may file applications in order to attract investors, employees, or consumers. It is important to keep in mind that many innovative firms do not seek patent protection, and that many of the registered patents remain unused later (on all these points, see Blind et al. 2006; Sichelman & Graham 2010; Torrisi et al. 2016; Hall 2018; Hall et al. 2014). If a company decides not to seek patent protection, this may be due to:

- the ease of inventing around a potential patent;
- the reluctance to disclose information through the patent document;
- the prohibitive costs of acquiring or enforcing a patent;
- the high speed with which technological change happens, compared to the long time it takes to receive patent protection; or
- the fact that the invention does not meet the patentability requirements.

In our interviews, we heard mixed opinions regarding first-time entry of companies into the patent system. On the one hand, inventors interested in creating start-up companies can benefit from a wide range of support, by technology transfer offices at Swiss universities and by the IPI. On the other hand, many startups have no idea about what a patent strategy is to begin with and why it is important. Despite significant efforts of the IPI over the last years, it seems that awareness about IP among startups and SMEs is limited, or at least unevenly distributed among such firms.

In the ICT sector, companies may use IP protection in order to protect platforms against competition. But they may still grant free access to Application Programming Interfaces (APIs) in order to encourage third parties to write applications running on their platforms (an approach adopted by Google with its Android mobile device operating system). Over time, e.g., IBM has become an important contributor to open source software projects, and it has released some of its patents to the public, thereby relinquishing some of its control through IP rights and embracing an "open innovation model". And various industry consortia have granted access to key patents covering particular technologies to members of the consortia and beyond. Such examples do not necessarily point to a dysfunctional IP system. They merely demonstrate that there are cases in which an IP rights holder may decide to give up control over some IP rights because he has found other, more indirect and potentially better ways to make profit (Google and IBM are for-profit enterprises, after all). Reducing control over IP rights in order to allow knowledge that was produced within a company to spill over to other companies (with the hope to receive knowledge spillovers from others in return) can be a legitimate and sensible use of the IP system (da Silva forthcoming; Merges 1996 & 2004).

As the example from the ICT sector illustrates, it would be erroneous to oppose open innovation to IP rights. These two approaches to managing innovation often complement each other. Laursen & Salter (2014) explain that innovating firms often need to engage openly with a large number of external actors. At the same time, firms need to capture the returns from their innovative ideas. This situation is called the "paradox of openness", in which the creation of innovations often requires openness, but the commercialization of innovations requires protection. Using survey data from innovative firms in the United Kingdom, Laursen & Salter (2014) show the existence of this dual approach to managing innovation within firms.

In a similar vein, note that patented inventions are not necessarily “closed” inventions. For one, they could have been developed using an open innovation model. This is the case, for instance, for inventions produced with the active involvement of consumers but where the final result is patented by the firm. Furthermore, patents have been shown to act as a vehicle that facilitates the transfer of technologies across innovating firms, thereby actively supporting open innovation (de Rassenfosse, Palangkaraya et al. 2016).

Our interviews confirmed that various industries combine aspects of sharing and hiding information about their inventions. In the engineering sector, e.g., combining patents with a successful strategy to protect complementary know-how can be key. Combining patent protection with the protection offered by other intellectual property rights, such as design protection or copyright, is routine in the electrical engineering sector. While patents are key in the pharmaceutical sector, there are also instances where inventions are kept secret in this industry. This applies to the protection of platform technologies or to cases where proving patent infringement in front of a court would be difficult. The disclosure by the patent system can also impact the timing of filing patent applications. As an interview partner from the crop and seed business noted, in industries requiring field tests during product development, filing patent applications early is a way to secure protection before novelty is destroyed through public tests.

Concerning the choice between patenting an invention and keeping it secret, one interviewee argued that trade secret in Europe is weaker than in the United States and that there is also more uncertainty (i.e., less case law) about what firms need to do in order to guarantee that an invention will indeed be considered a trade secret. Another interview partner from a small company noted that he prefers relying on patents instead of trade secrets because trade secrets are difficult to protect against MNEs with large R&D capabilities. Providing evidence on both theft of trade secret and on infringing a patent can be challenging. One interview partner noted that keeping details about the manufacturing process secret can be an important asset even in industries that otherwise heavily depend on patenting.

Furthermore, our interviews revealed that the companies’ approach towards patenting is embedded in a broader corporate innovation strategy. Companies adopt sophisticated strategies to optimize the revenue stream from patented inventions. Several interview partners commented on patenting strategies in which revenues are not only generated by primary products, but by secondary consumable products, similarly to the strategy Nestlé implemented with its Nespresso system. One interview partner also noted that patent owners may build up brands for products during patent protection and then count on consumer loyalty and trademark protection of the brand after patent protection expires. Another interview partner from a small electronics company described a very sophisticated approach to IP, with a well-thought patent thicket strategy and regular patent harvesting sessions. Another interview partner explained how his company often initially files numerous patent applications in many countries on various aspects of an invention, while then subsequently dropping some of these applications and focusing on particular countries once it becomes clear which aspect of the invention will turn into a successful product in which markets.

The *third* reason why it is challenging to determine the practical importance of patent protection for innovation policy concerns the sharing of information. Patents are not always used to exclude others; they are sometimes shared with members of a community to facilitate adoption of a technology. The open source software industry is a prime example in which copyrighted works are shared with quite permissive restrictions. In that industry, intellectual property law is not used as an appropriation mechanism. Outside the software industry, an entire literature stream has explored how various creative industries—ranging from large industries such as fashion to niche markets such as TV shows (Raustiala & Sprigman 2016; Bechtold 2013)—seem to thrive despite their limited use of IP protection as an appropriation mechanism.

In addition, the free flow of information among competitors seems an important ingredient to vibrant knowledge production in some industries. Empirical research on regional clusters such as Silicon Valley suggests that the ability of employees to move to new employers, thereby moving knowledge between firms without legal restrictions, can contribute to a vibrant regional innovation cluster (Saxenian 1994; Gilson 1999; Marx & Fleming 2012; Marx et al. 2015). Furthermore, historical evidence suggests that countries can also benefit, in various stages of their development, from a low level of protection (see Moser 2005, noting that Switzerland did not have full patent protection until 1907).

The *fourth* reason why it is challenging to determine the practical importance of patent protection for innovation policy concerns empirical evidence, notably the difficulty in establishing causality. For a long time, empirical research on the impact of the patent system suffered from methodological problems and limited availability of data (Cohen 1989: 1061). However, recent advances in econometric techniques have enabled empirical industrial organization research to cleanly identify the causal impact of a policy intervention (Angrist & Pischke 2010). These techniques include event studies, difference-in-difference analyses, regression discontinuity designs and instrumental variable approaches. They have increasingly been applied to patent policy research. For instance, several studies have analyzed whether strengthening patent protection encourages research investments (Sakakibara & Branstetter 2001; Lerner 2009; Budish et al. 2015). While some of these studies indicate some positive relationship between patent protection and investment levels, overall, they do not provide conclusive proof of such relationship—again mostly due to limited availability of data (Williams 2017: 456).

Other recent empirical studies comparing patented with non-patented inventions have found mixed evidence on the impact of patents on follow-on innovation. Galasso & Schankerman (2015) find that patent rights block downstream innovation in computers, electronics, and medical instruments, but not in drugs, chemicals, or mechanical technologies. Sampat & Wil-liams (2019) find no effect of patents on downstream innovation in biology. Again, the impact is likely to vary across industry sectors, firm sizes and other characteristics (Williams 2017: 464). Furthermore, the empirical historical evidence on the impact of patent protection on innovation is also mixed: the effectiveness of the patent system seems to have varied widely across industry sectors in the 19th and early 20th century, and many innovations occurred outside the patent system (Moser 2016).

Do Patents Disclose Relevant Information?

In order to be granted a patent, the inventor must disclose sufficient information for a person skilled in the art to replicate the invention. This disclosure of technical information should enable other inventors to learn about technological advances by reading the patent literature. In practice, there is mixed evidence on whether the patent system indeed helps spread knowledge about new inventions.

Some scholars have investigated the disclosure function of the patent system by asking patent inventors whether they were knowledgeable about the cited patent literature made in their own patents. This question is important because many patent citations are added by patent attorneys and by patent examiners. Presumably, if inventors are not aware of the closest patents in their field (and that are consequently cited in their patents), the claim that inventors learn from the patent literature is weakened. However, the reverse is not necessarily true: the fact that inventors are knowledgeable about some cited patents does not imply that they have learned from such patents—they may have discovered the patents after the invention was made. Jaffe et al. (2000) and Duguet and MacGarvie (2005) find that inventors know of some of the cited patents, but, overall, that the patent literature is not a prime source of learning.

A more direct approach has been undertaken recently by Lisa Ouellette. She surveyed researchers active in the field of nanotechnology. She reports that 64% of respondents have read patents, and of these respondents, 70% looked to patents for technical information. Of those reading patents for scientific (rather than legal) reasons, 60% found useful technical information, indicating that patents are serving a useful disclosure function for these early-stage researchers. However, Ouellette also concludes that the disclosure function of patents could be greatly improved (Ouellette 2015, 2017).

In the interviews we conducted, most interview partners explained that they have many ways to learn new developments in their field (trade shows, interacting with universities, reverse engineering, etc.). Our overall impression from the interviews was that, in many industries, patent documents are not a key learning channel. Besides, at least for some inventors, patent documents are both obscure and difficult to understand, and the 18-month publication delay significantly diminish learning opportunities.

However, in some instances, the patent system may provide effective disclosure of inventions. Some of our interview partners reported of regular screening of patent applications to
stay informed about their competitors' product development. The case of a Neuchâtel-based company that closely monitors the patent literature (and other public sources) to screen recent developments in the watch industry is particularly interesting in this respect. It shares its findings with its member watchmakers so that they can keep abreast of recent developments. Thus, the patent literature is an important source of technical information in this industry.

Can Patent Protection be Harmful to Innovation?

In addition to considering the benefits associated with patent protection, one may wonder whether there are contexts in which patent protection might be harmful to innovation. On a theoretical level, various potential costs of the patent system can be identified, six of which will be described in the following: (1) static inefficiencies due to monopolies; (2) dynamic inefficiencies due to cumulative innovation processes; (3) inefficient generalizations in the patent system; (4) strategic behavior by patent owners; (5) costs of running a patent system; and (6) the pressure the patent system can create for universities.

Static Inefficiencies due to Monopolies

First, concerning static inefficiencies, a patent enables its owner to charge a price that is higher than the hypothetical market price that would emerge in a competitive market. The economic analysis of monopolies demonstrates that charging supra-competitive prices comes at a social cost.

Box 4. Monopolies in Economics

In classical economic terms, a monopoly exists if a seller is the only supplier of a particular good. Compared to a seller in a "perfectly" competitive market, a monopolist is not constrained by his competitors in setting the price for his good. Rather, he will set a price that lies above his marginal costs in order to maximize his profit. Thus, consumers pay higher prices than in a perfectly competitive market. In reality, pure monopolies are rare (the mere threat of new entrants may induce monopolists to reduce prices) so are "perfectly" competitive markets. However, the fact remains that monopolistic markets are characterized by higher prices. By setting high prices, the monopolist drives some consumers out of the market: those consumers who would be willing to buy the good at the lower competitive price but are unwilling to pay the higher monopoly price. As a result, compared to a competitive market, lower quantities of the good will be sold at a higher price by a monopolist. This so-called "deadweight loss" is a market failure caused by a monopoly.

Not all patents lead to monopolies in an economic sense. As long as close substitutes exist to the patented product or process, a patent will not lead to a monopoly. If such substitutes are not available, a patent can create, however, a socially inefficient deadweight loss from a static perspective: patent protection allows the inventor to charge supra-competitive prices for his patented product, which will decrease the number of consumers who are willing to buy the product.

Even though patent protection may thereby create social costs in a static setting, this does not mean that patent protection should be condemned. As described above, without patent protection, the invention may not have been produced in the first place, which would create an even higher social cost than the deadweight loss resulting from patent protection.

The insight of the monopoly analogy for patent policy is not that one should abolish the patent system, but rather that one should be careful to not over-extend patents either in breadth or time, as this may harm consumers and society at large. This analogy also calls for maintaining a sufficient level of quality in the patent system: if patents were granted for trivial inventions that would have been developed even in the absence of patent protection, then the argument related to incentivizing inventors is weak. From an economic welfare perspective, patents should be granted only for inventions that would not have been developed without the patent system—if an invention would have been developed anyway, there is no economic rationale for imposing a cost to consumers in the form of a monopoly right. Patents on such trivial inventions are purely opportunistic and do not improve welfare. Since identifying such inventions in practice is unfeasible, patent offices set a minimum inventive step threshold that inventions should meet in order to deserve patent protection. Low quality in patent systems is thus potentially detrimental to welfare (de Rassenfosse, Jaffe et al. 2016). In fact, recent empirical studies have highlighted the substantial proportion of granted patents that are invalid (Henkel & Zischka 2018; Weatherall and Jensen, 2005; Helmers and McDonagh, 2013). This may indicate that some patent offices flood the patent system with too many low-quality patents, although substantial differences between patent offices exist (de Rassenfosse, Jaffe et al. 2016).[4] In line with this argument, several of our interview partners were critical of the current patent system in that many patents are generated that do not create lasting value, but just clutter up the system.

Dynamic Inefficiencies due to Cumulative Innovation Processes

A *second* potential cost of the patent system concerns dynamic inefficiencies. Patent protection does not only impact consumers who are interested in benefiting from the invention, but also other inventors who want to build upon that invention. Compared to a world with no patents, patent protection raises costs for follow-on inventors who need a license from the original inventor in order to improve upon her invention. This cost is particularly acute in the case of cumulative technologies that build on a large number of previous patents. It involves both a monetary cost (in the form of licensing fee) and a transaction cost (including identifying the original inventors and agreeing on contractual terms).[5]

Designing optimal patent laws therefore involves a tradeoff between static and dynamic efficiencies, especially in areas characterized by cumulative innovation. From a static perspective, one may want a strong patent protection in order to provide incentives to invent. From a dynamic perspective, however, one may want to limit such patent protection in order to minimize the burden this creates for follow-on inventors (Scotchmer 1991). Limiting intellectual property protection can also be a good idea from a macroeconomic growth perspective as, otherwise, the patent system might overprotect some inventions, leading to decelerated economic growth (Acemoglu & Akcigit 2012).

A related issue concerns inventions around an existing patent. There are various cases in which a patented invention is not available to competitors: either the patent owner does not grant a license (and may even decide not to use the patent himself, thereby effectively suppressing the technology, see Tyler 2014), or competitors interested in the patented invention decide not to enter into a licensing agreement with the patent owner for competitive reasons. While it may seem troublesome that the patented invention is not put to an effective use in such cases, it is important to note that the lack of access to a patented invention may also trigger new innovation and increase technical variety, as competitors may be forced to come up with solutions that invent around the unavailable patent (Buccafusco et al. 2017).

[4] Using data from revocation proceedings, Henkel and Zischka (2018) estimate that about 80 percent of patents in force in Germany are likely to be invalid. Other studies point to lower rates of invalidity (e.g., Weatherall and Jensen, 2005; Helmers and McDonagh, 2013) but still above 50 percent.

[5] To deal with the extreme fragmentation of patent rights across actors, some industries have developed so-called patent pools, see, e.g., Shapiro (2000).

Box 5. Innovation Triggered by Inventing Around Patents

A good example is the market for high-voltage power equipment. The Swiss company ABB produces gas-insulated high-voltage switchgears that use a gas mixture for electric insulation and arc interruption. Traditionally, SF6 was used as insulating gas. However, SF6 is a potent greenhouse gas. Therefore, a replacement gas had to be developed. ABB's new gas mixture is based on a fluoroketone that was developed by ABB, together with 3M. Over the years, ABB received over 100 patents on the use of this gas mixture for high-voltage power equipment. Competitors to ABB could either try to license those patents, or they could try to develop alternative solutions that do not rely on ABB's patented inventions. Indeed, ABB's competitors have been successful in inventing high-voltage switchgears that are not based on fluoroketones, but are equally climate-friendly, thereby arguably promoting progress and increasing access to diverse technical solutions.

Inefficient Generalizations in the Patent System

A *third* potential cost of the patent system concerns generalizations (or lack thereof). Patent law has traditionally not distinguished between different industry sectors or technology areas. The length, scope and enforcement of patents is, in general, the same across all sectors. There are some exceptions to this rule. In the pharmaceutical industry, for example, supplementary protection certificates (SPCs), data protection and market protection can *de facto* lead to an extension of the patent term. Furthermore, abstract ideas as such are not patentable. As a result, the European Patent Convention excludes new methods of doing business as such from patentability, and recent case law by the U.S. Supreme Court has severely restricted the patentability of business methods under U.S. patent law.[6] In the computer industry, the European Patent Convention excludes software programs as such from patentability, although software patents are available to inventions whose technical contribution goes beyond the normal physical interaction between the program and a computer. Overall, however, patent statutes have remained technology- and industry-agnostic.

Still, from an ex ante perspective, it might very well be the case that an ideal patent system should provide different incentives to different technology sectors. While scholars have argued that courts can, and should, introduce such distinctions between technology areas into patent law (Burk & Lemley 2009; van Overwalle 2011), the current patent system has probably not reached an optimal level of differentiation. Some of our interviewees argued that the patent system should be more tailored to particular industries. Taking the pharmaceutical industry as an example, the *de facto* length of patent protection in this industry may be several years shorter than in the engineering sector because of regulatory delays, even after taking supplementary protection certificates into account.

Tailoring patent law to particular industries is a contested issue, though, and some interview partners were hesitant to do so. They argued that it would be very difficult in practice to design sufficient distinctions between technology areas that are easy to implement and enforce. Besides, some interview partners noted that the patent system is already tailored to some extent. In industries with shorter life cycles, inventions

[6] Bilski v. Kappos, 561 U.S. 593 (2010); Alice Corp. v. CLS Bank Int'l, 573 U.S. 208 (2014).

will become obsolete faster and the patents will simply lapse faster, thereby inducing heterogeneity in patent life across technologies.

Strategic Behavior by Patent Owners

A fourth potential cost of the patent system is that it may open the door to abusive strategic behavior. A too strong protection may lead to so-called “patent races” in which companies overinvest in R&D in order to receive patent protection first. Patent races may lead to the duplication of R&D efforts and are thus potentially wasteful. Furthermore, in industries in which licenses from many overlapping patents are necessary in order to make a product (as is typically the case in information and communication technologies), so-called “patent thickets” may lead to a breakdown of licensing markets because of high transactions costs, royalty stacking and strategic behavior. “Patent pools” may have ambiguous effects on competition. And “non-practicing entities” (also called “patent trolls”) may enforce patent rights far beyond the patent’s actual value, without manufacturing products or supplying services themselves. It is beyond the scope of this Report to describe the empirical debates on the relevance and social implications of such behaviors (see, e.g., Comino et al. 2019). Suffice it to say that it is not surprising that actors use the patent system to advance their own interests, which may not coincide with society’s interest in using the patent system as a tool to provide incentives for innovation. This calls for continuously adapting and fine-tuning the patent system to limit the effect of such behavior.

It is important to note that opportunities to behave strategically under a patent system may vary widely from industry to industry. Some of our interview partners noted that, in the life science sector, a product is often the result of one key compound, which is covered by a single patent. For such discrete technologies, there is a simple link between one patent and one product. As a result, patent thickets do not play a major role in the pharmaceutical sector.

Cost of Running a Patent System

A fifth potential cost of the system concerns the mere cost of running such a system. These costs are usually borne by patent owners and, potentially, defendants in patent infringement lawsuits. Designing the patent system in different ways can influence the direct costs of operating the system. As the IPI does not engage in a full examination of patent applications (see Box 9), it can provide a comparatively lean patent system. Our interview partners have mixed opinions on whether the Swiss patent system should move to a full examination system. Some applauded such proposal as this could:

- reduce the number of low-quality patents, many of which are opportunistic in the sense that inventions would have been produced in the absence of the patent system;
- increase the reputation of the Swiss patent system;
- potentially provide a much faster way to a patent than the system maintained by the European Patent Office;
- align the Swiss patent system with internationally accepted patent boxes that may be introduced in Swiss tax law in the near future; and
- benefit small and medium enterprises for which it may be too costly to receive a patent from the European Patent Office.

Others did not really see the need for such change, as:

- it is already possible to receive a fully examined patent in Switzerland through the application procedure at the EPO—and in fact, more than 90 percent of patents in force in Switzerland have been fully examined;
- such move would be going against the trend in other countries since there has been a tendency to move away from substantive examination in some national offices with the introduction of the EPO;
- there may be relevant self-interests of the IPI and of Swiss patent attorneys to upgrade the Swiss patent system;
- building up a high-quality examination system is costly, which raises questions about the cost/benefit tradeoff;
- filing at the IPI is not a priority for some globally oriented companies.

Box 6. Overview of the Cost of Patenting

Obtaining—and enforcing—patent protection is costly. Besides the fees requested by the patent office, the cost includes fees paid to the patent attorney for drafting the patent document and for managing the prosecution process. The cost can skyrocket if the patent is litigated to trial.

Expenses and fees for patent protection may include:

1. Preliminary searches, developing the patent application strategy and preparing the technical documents
2. Support from specialists during the patent prosecution process
3. Application fee
4. Translating the patent application and patent specification
5. Fees for searches and the patent examination
6. Renewal fees for keeping the patent in force
7. Costs for enforcing the patent

Items 3, 5 and 6 are paid to the IPI and are below CHF 10,000 (cumulated over the life of the patent) to maintain a patent to full term. The application fees, which are due at the time of filing, are set at 200 CHF, while search and examination fees reach at least 1000 CHF. Attorney fees (items 1, 2 and potentially 4) can widely vary depending on the complexity of the technology. However, it is usually estimated that they are in the CHF 5000–15,000 range. Finally, litigation can cost several hundreds of thousands of Swiss francs, and sometimes millions in lengthy and complex cases—also depending on the jurisdictions; litigation being particularly expensive in the United States.

In our interviews, we frequently heard, both from small and large companies, that the patent system is prohibitively expensive—and sometimes deter small companies from patenting. Official fees and attorney fees are compounded for multi-jurisdictional patents, and enforcing the patent in court is often not an option for cost reasons. In addition, the patent system is very complex and obscure for companies that have never been exposed to it.

Source: Adapted from https://www.ige.ch/en/protecting-your-ip/patents/before-you-apply/costs-and-fees.html. Data on cost of attorney and litigation based on informal discussion with attorney firms.

Interview partners generally noted that moving to a full examination system only makes sense if the grant decision is fast, reliable and cheap. Furthermore, the current patent system should then probably be morphed into a system of utility models (or "petty patents").

The patent system can also generate costs when it comes to enforcing patents. Some interview partners noted that litigation cases are usually costly and lengthy. A patent filed at the EPO and validated in Switzerland can be opposed after grant, the decision can be appealed, and if the patent is upheld, it can be attacked at national level(s). The whole procedure in order to know whether a patent is finally enforceable can take 9 to 10 years from the filing date, according to an interview partner. Another interview partner noted that the Swiss Federal Patent Court, which was established in 2012, could play a role in increasing the attractiveness of Switzerland as an IP hub. He suggested that the court could position itself in providing fast and reliable decisions, which parties could exploit to settle their litigations in other jurisdictions.

Pressure the Patent System Can Create for Universities

A *sixth* potential cost of the patent system concerns the pressure the system puts on universities. The ability of university researchers to file for patent protection has increased the expectation worldwide that universities exploit their patent portfolio, thereby tapping new funding resources. However, our interviews demonstrated that when it comes to inventions at universities, technology transfer offices often do not see their primarily role as contributing significantly to the budget of their university. Even when major U.S. universities enjoy significant patent licensing revenues, the revenues often result from one or two blockbuster patents, rather than from a broad patent portfolio. Furthermore, insofar as research groups focus on basic research, they may be far apart from commercialization and patenting considerations.

As a result, patent revenues typically do not provide a stable and significant source of income for universities. One interview partner noted that financing universities with revenues from patents would be similar to financing universities with lotteries, because patent licensing is very unpredictable. Furthermore, many technology transfer offices in Europe and the United States are actually cost centers. The primary role of technology transfer offices is to facilitate knowledge transfer from universities into society by providing support and counselling for young entrepreneurs and start-up companies, and to enable industry cooperation between universities, SMEs and MNEs. Nevertheless, at research-focused universities, it is important that researchers do not only understand the science that lies beneath their invention, but also get equipped with the necessary tools to turn that invention into innovative products.

So, Where Do We Stand?

While the basic theoretical arguments justifying the patent system have been known for a long time, verifying their relevance empirically has proven challenging. Sixty years ago, the economist Fritz Machlup famously wrote in a report to the U.S. Congress:

> "No economist, on the basis of present knowledge, could possibly state with certainty that the patent system, as it operates, confers a net benefit or a net loss upon society. […] If we did not have a patent system, it would be irresponsible, on the basis of our present knowledge of its economic consequences, to recommend instituting one. But

> since we have had a patent system for a long time, it would be irresponsible, on the basis of our present knowledge, to recommend abolishing it" (Machlup 1958: 79–80).

Even sixty years later, the scientific literature has not been able to provide a definite answer to the question of whether the patent system advances welfare. While some academics take very bold perspectives on the patent system (see, e.g., Haber 2016 and Boldrin & Levine 2013), the hard empirical evidence is still unsatisfactory. In fact, MIT economist Heidi Williams argued in a recent survey of the available empirical evidence that "we still have essentially no credible empirical evidence on the seemingly simple question of whether stronger patent rights—either longer patent terms or broader patent rights—encourage research investments into developing new technologies" (Williams 2017: 464).

This does not mean, however, that the current patent system should be abolished or reformed in a radical way.[7] The incomplete evidence may also be due to the fact that

- some of the data that would be necessary to answer the grand question of patent policy research either does not exist or is not available to independent researchers;
- the available research methods to identify causal relationships between policy interventions and outcomes are insufficient; or, more radically,
- that it is practically impossible to provide a welfare analysis of the patent system in general, as its effects are likely to be highly heterogeneous across industries, time, countries, legal regimes, and many other factors. Furthermore, such analysis is complicated by the fact that the use of the patent system has implications for market entry opportunities, industry structure, and the rate of technological change itself.

What we are left with at this point is a general notion that, in core fields such as life sciences, a strong case can be made that the patent system encourages innovation and ultimately promotes social welfare. Several reasons exist why life sciences (including the pharmaceutical industry) may benefit particularly from the patent system, compared to other fields. First, the R&D costs are particularly high in this area, making tools to recoup investment costs a crucial issue. Second, pharmaceutical drugs are typically discrete products, often with a clear link between one patent (or a limited number of well-identified patents) and one drug. Third, compared to other technology fields, cumulative innovation is less pronounced and occurs with a more limited set of actors. This renders some of the potentially harmful effects of the patent system less relevant.

As was noted before, one should always keep in mind that the beneficial effects of the patent system in one industry do not necessarily translate to other industries, and that there are many different ways in which innovation policy can encourage innovative activities. As a result, patent policy will have to continue to operate despite the limited robust empirical evidence about its effectiveness.

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[7] In fact, this point was already noted by Edith Penrose in 1951: "If national patent laws did not exist, it would be difficult to make a conclusive case for introducing them; but the fact that they do exist shifts the burden of proof and it is equally difficult to make a really conclusive case for abolishing them" (Penrose 1951: 40).

This literature review indicates that the academic debate on patent policy is conducted on an international level. Given the high level of harmonization of the patent systems worldwide, many of the insights from this debate can also be applied to Switzerland. Still, there is only limited evidence for Switzerland available.[8]

[8] Interesting studies on the use of IP by Swiss SMEs are provided in Radauer & Streicher (2008); Keupp et al. (2009); and Friesike et al. (2009). The 2016 version of this Report provided some statistics on filing patterns in the Swiss patent system on pp. 89-93 and 107-108 (Swiss Confederation 2016). For further studies, see Arvanities et al. (2015); Arvanitis et al. (2017); Chatagny et al. (2017); Moser 2005.

4. Quantitative Evidence: Switzerland as an International Technology Leader

This section provides data to illustrate two particular aspects of the Swiss patent system:[9] First, Swiss patenting (and research) activity is dominated by a set of highly international companies. Switzerland is known to be a small open economy, and this fact is also visible in patent data. Second, Switzerland is an innovative country at the frontier of research. The leading role of Switzerland in emerging technologies is also visible in patent data.

These two features are important in order to understand the role of patents in Switzerland. Because innovative companies are very internationally oriented, their patenting strategy is usually global in nature. Thus, the Swiss patent system alone has limited impact on the research incentives and activities of Swiss firms. Furthermore, the fact that Switzerland is an innovation leader confirms the importance of patent rights—Swiss *and* foreign—for Swiss firms.

Preliminary Note on Patents and the Measurement of Innovation

Before documenting these two features, we start with a general note of caution about the use of patent data to study innovation. One can think of two broad ways of measuring innovation. Innovation can be measured at its "source," with metrics such as the share of sales that come from new products or the number of patents filed by a firm. Innovation can also be measured through the "ultimate effects" it induces, with metrics such as the increase in life expectancy and other quality of life metrics.

Innovation economists have traditionally measured innovation at its source. The most direct metrics are survey items. The Oslo manual (OECD/Eurostat, 2005) provides an authoritative framework for countries to develop internationally comparable innovation surveys. It seeks to measure innovations broadly, ranging from technological product and process innovation to marketing and organizational innovation. Other firm-level metrics include R&D expenses and the number of scientists and engineers employed (input), or the number of scientific publications published (output).

Commonly used metrics at the firm level include data about IP. In addition to patents held by firms, trademarks are being increasingly used to assess innovation performances. Trademarks are designed to differentiate certain products from those provided by other firms. In this context, the filing of new trademarks by firms partially reflects the introduction of new offerings aimed at persuading potential buyers that the range of their problems is not being solved by the supply of solutions currently available in the market (Mendonça et al. 2004). As trademarks closely precedes market introduction, they provide a near real-time measure of innovation. They are also particularly useful to measure innovation in the service industry, which traditionally relies less on technological innovation (Flikkema et al. 2014).

[9] The data used in this section come from the "Patent Sight" patent analytics software, unless otherwise noted. We are grateful to Jochen Spuck and Christian Moser from the IPI for their help in extracting the raw data from Patent Sight.

Patents protect inventions and can, therefore, be considered an intermediate step between R&D (situated upstream in the innovation process) and innovation (see also Section 2). Several of our interview partners were also critical of empirical measures of innovativeness, based on patent filings, as a granted patent does not mean that the patented invention has led to a commercially successful product. Besides, there is no one-to-one link between patents and innovations—there can be many patents per innovation, and a patent can be used in several innovations. Box 7 presents an example from the medical devices industry to illustrate the point.

Box 7. Illustration of the Link between Patents and Innovation

Hamilton Medical AG, established in Bonaduz (GR) in 1983, is a leading manufacturer of critical care ventilation solutions. Its ventilators are protected by several patents, filed in Switzerland and elsewhere. The company provides on its website the correspondence between its products (innovations) and the patents that protect them (inventions).

For example, the ventilator HAMILTON-C3 (depicted) is protected by 28 granted patents and a further 18 pending patent applications. The granted patents cover the following jurisdictions: Japan, Germany and the EPO (7 patents each), the United States (3 patents), China (2 patents), Switzerland and Austria (1 patent each).

This example illustrates that there is not a one-to-one relationship between innovations and inventions. It also highlights the importance of foreign patent protection for Swiss firms.

Source: https://www.hamilton-medical.com/Patents.html

Three additional caveats associated with using patent data to assess innovativeness are warranted. First, the distribution of value is highly skewed, with the majority of patents being worth little and a minority of patents having very high value (e.g., Trajtenberg 1990). It is thus important to adjust patent statistics to reflect the underlying economic and technical value of the inventions.

Box 8. Patents as Property Right

While patents are rights to exclude other from using the patented invention, they are special kinds of property rights. Empirical research has shown that it is only a small number of patents that generate lots of revenue over their life time (Schankerman 1998; Harhoff et al. 2003). In addition, only a small number of patents are ever litigated (Lemley & Shapiro 2005), and these patents always face the risk of being invalidated. This skewed distribution of patent value has important policy implications, as there is a certain probabilistic feature to patents. Skewed value distributions are not restricted to patented inventions, but can also be found in other innovative industries, e.g. books and music (Sorensen 2007, 2017).

Second, there are many ways to count patents, and every count has a different interpretation. For instance, innovation rankings sometimes rely on the number of patents granted to applicants in a country as one dimension of innovativeness. But the decision by a firm to file patents in one jurisdiction rather than in another is sometimes driven by tax considerations. As a result, the number of patents held by companies established in Switzerland may not necessarily adequately capture the innovativeness of Switzerland (OECD 2017, 96–97).

In a similar vein, the reliance on regional or international patent offices differs across countries. de Rassenfosse & van Pottelsberghe (2007) show that the transfer rate of priority filings at the European Patent Office (EPO) for European Patent Convention (EPC) member states increase with the duration of EPC membership. This finding suggests that there is a learning curve in the use of the EPO. This has implications for the use of Patent Cooperation Treaty (PCT) patents to compare country innovation performance: because the World Intellectual Property Organization (WIPO) is based in Geneva, one could argue that Swiss firms are, on average, more exposed to or familiar with the PCT system and may be more likely than firms in other countries to use the PCT route. Thus, country counts of PCT patent applications may be particularly favorable to Switzerland. Finally, the decision to file for patents is also driven by strategic considerations, as explained in Section 3.

Box 9. Different Routes to a Patent in Switzerland

If a company seeks patent protection in Switzerland, it can take four different routes:

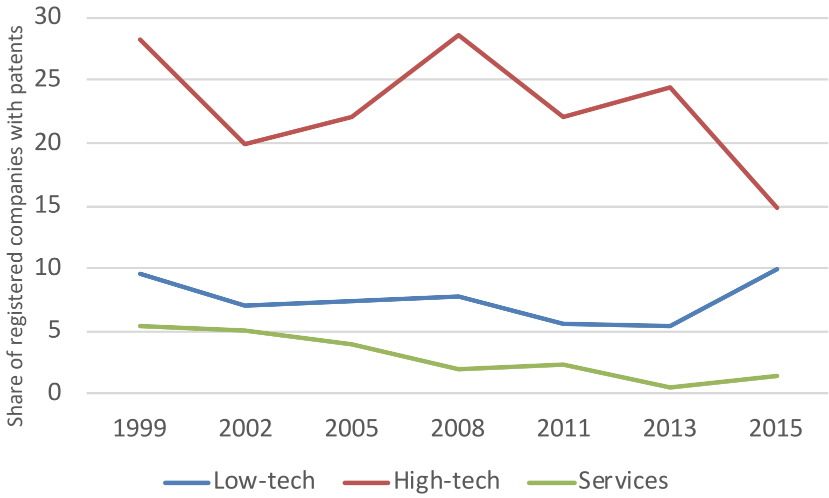
- *The national route*: The company may file a patent application with the IPI. The IPI will examine the application, without examining the inventive step and the novelty of the invention (no substantive examination).
- *The EPC route*: The company may file a patent application with the EPO. The EPO is located in Munich and is based on the EPC, which is an international treaty that is separate from the European Union. The EPO will engage in a full examination of the patent application and may grant a patent with Switzerland as one of the designated countries, as Switzerland is a member state of the EPC. This will lead to a national patent in Switzerland, just as through the national route.
- *The PCT route*: The company may file a patent application with WIPO in Geneva under the PCT. After an international search for relevant prior art and an optional preliminary examination, the application is transferred to the IPI to grant a national patent.
- *The Euro-PCT route:* It is a combination of the EPO and the PCT routes. It involves filing a patent application at the EPO under the PCT.

In the European Union, there are plans to create a Unitary Patent that would provide uniform protection throughout most member states of the European Union by a single patent system, thereby supplanting national patent systems. As Switzerland is not member of the European Union, it cannot participate in this system. Note that the introduction of the Unitary Patent would not abolish the EPC and Euro-PCT routes.

Third, it is important to bear in mind that patenting is overall a rare event. It is low at the extensive margin (few firms file for patents), but high at the intensive margin (when firms file for patents, they usually file many). Figure 1 and Figure *2* provide an overview of the patenting activity at the extensive margin among Swiss firms. The data comes from the Swiss Community Innovation Survey and captures the proportion of firms that reported having filed for at least one patent over the survey period (from 1997–1999 to 2012–2014).

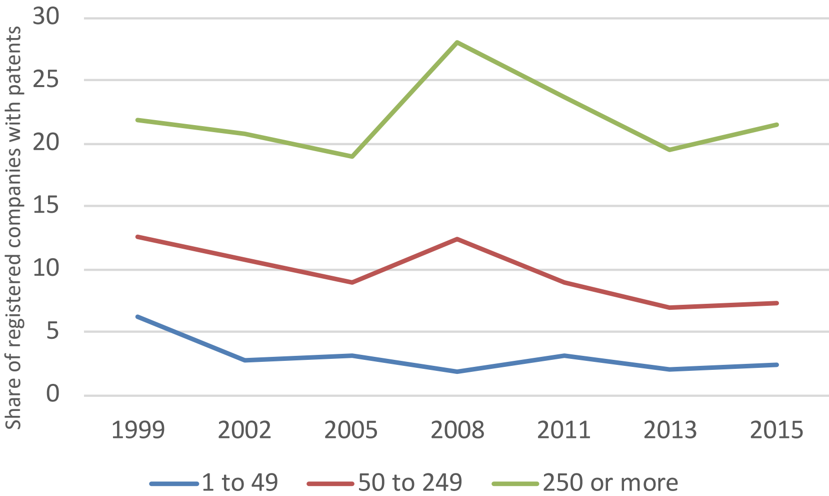
Figure 1 shows that 20 to 25 percent of high-tech firms in Switzerland file for patents, whereas only 5 to 10 percent of low-tech firms and 0 to 5 percent of firms in the service industry do. Regarding firm size, Figure 2 shows that large firms have the highest propensity to patent (20 to 25 percent), followed by SMEs (about 10 percent) and small companies (below 5 percent).

Figure 1. Patent Intensity at the Extensive Margin by R&D Intensity of Companies



Source: Adapted from Arvanitis et al. (2017) using data from the Swiss Community Innovation Survey. Proportion of Swiss firms reported having filed at least one patent during the survey period.

Figure 2. Patent Intensity at the Extensive Margin by Number of Employees



Source: Adapted from Arvanitis et al. (2017) using data from the Swiss Community Innovation Survey. Proportion of Swiss firms reported having filed at least one patent during the survey period.

“Swiss” Firms are Highly Internationally Oriented

This section illustrates the international nature of Swiss patentees along two main dimensions: origin of inventors and use of foreign patent systems. The processing of patent data involves a large amount of manual work. We have therefore focused our attention to the largest patentees.

Origin of Inventions by Swiss Firms

Table 2 below provides an overview of the patent portfolio of large Swiss patentees (with more than 100 active patents). It includes 65 multi-national enterprises (MNEs), three universities (EPFL, ETH Zurich, and the University of Zurich) and two R&D institutions (Swiss Center for Electronics and Microtechnology, and Paul Scherrer Institute).

Defining the “nationality” of an MNE is notoriously challenging, for MNEs being global by nature. The case of STMicroelectronics illustrates the global nature of some companies in the list. STMicroelectronics is headquartered in Geneva, but the company is incorporated in the Netherlands and trades on Euronext, BIT, and NYSE. It results from the merger of two semiconductor companies, the Italian SGS Microelettronica and the French Thomson Semiconducteurs. In the table below, we restrict our attention to firms that are headquartered in Switzerland. Also, we adopt an ad-hoc definition of MNEs: assignees holding more than 100 active patents as of April 2018. These patents are not necessarily all filed in Switzerland. In the context of this Report, a “Swiss MNE” is a corporate patentee with more than 100 active patents and with corporate headquarters in Switzerland.

It is well known about patents that they greatly differ in their quality and economic value (e.g., Griliches 1990). Some inventions are truly radical while some others barely meet the inventive step threshold require for a patent grant. Similarly, some inventions will turn into financial blockbusters while some others will be a financial loss to their owners. Table 2 below provides both a raw patent count (column 3) and an adjusted count (column 4).

The adjusted patent count exploits the PatentAsset Index, which is a proprietary measure developed by Patent Sight (Ernst and Omland 2011).[10] It reflects the aggregate value of patents in a portfolio and captures the technology relevance and the market coverage of the active patent families in a portfolio. A patent family is defined as a set of related patents that protect a core invention (see Martínez 2010 for details). Patent families that protect a large number of jurisdictions (the measure of patent coverage) and that are highly cited by subsequent patent applications (the measure of technology relevance) will have a large value for the PatentAsset Index.

The last column in Table 2 presents the share of patents in the portfolio that were actually invented in Switzerland. We proxy the country of invention by the country of residence of inventors as listed in the patent documents. This information should be treated with caution because the country of residence of inventors is not always reported accurately in patent documents, and because the country of residence is not

[10] Patent Sight is a patent analytics online platform that provides harmonized data on patent offices worldwide. See https://www.patentsight.com/en-us/about-patentsight. It is similar to other services such as Derwent Innovation. Access to the Patent Sight software was provided through the IPI.

necessarily the country where the inventive activity actually took place (e.g. in the case of cross-border commuters). Nevertheless, it gives a rough indication of the local embeddedness of assignees. For instance, the majority of inventions by Nestlé are made in Switzerland, whereas STMicroelectronics has virtually no inventive activity in Switzerland. The majority of the 65 MNEs have the majority of their patents that are invented abroad.

Table 2. Patenting Activity by Swiss MNEs and Other Large Patentees

Assignee name	**Industry**	**Portfolio size**	**PatentAsset Index**	**Share invented in Switzerland**
STMicroelectronics	Electronics	9'697	9'587	0.80%
ABB	Electrical equipment	7'435	14'016	23.00%
Roche	Pharmaceuticals	6'325	29'960	31.00%
TE Connectivity	Electronics	4'803	9'324	0.40%
Novartis	Pharmaceuticals	4'092	19'039	31.80%
Nestle	Food processing	2'879	13'850	59.20%
Endress+Hauser	Instrumentation	2'614	5'214	27.40%
Swatch	Watchmaking	2'566	4'621	93.10%
Tetra Laval	Packaging, processing and distribution solutions	2'192	5'126	14.10%
Syngenta *(now: ChemChina)†*	Chemicals	1'910	5'610	37.69%
Liebherr	Manufacturing	1'645	2'227	2.90%
Clariant	Chemicals	1'258	3'197	4.70%
Schindler Holding	Manufacturing	1'122	4'168	74.90%
OC Oerlikon	Engineering/ Construction	893	1'943	27.00%
Sonova	Medical devices	866	1'561	54.00%
Kudelski	Digital television	760	1'760	45.40%
Sika AG	Chemicals	738	1'792	61.90%
Rehau Gruppe	Plastics	678	639	1.50%
Rieter Holding	Textiles Machinery	672	1'207	44.90%
Ineos	Chemicals	655	1'377	3.20%
Lonza	Chemicals	633	1'565	22.00%
Sulzer AG	Industrial engineering and manufacturing	577	1'499	47.80%
Bucher Industries	Machinery	549	693	5.50%
EPFL	University	526	1'850	99.60%
Logitech	Electronic peripherals	443	870	38.60%
ETH Zurich	University	426	1'193	98.40%

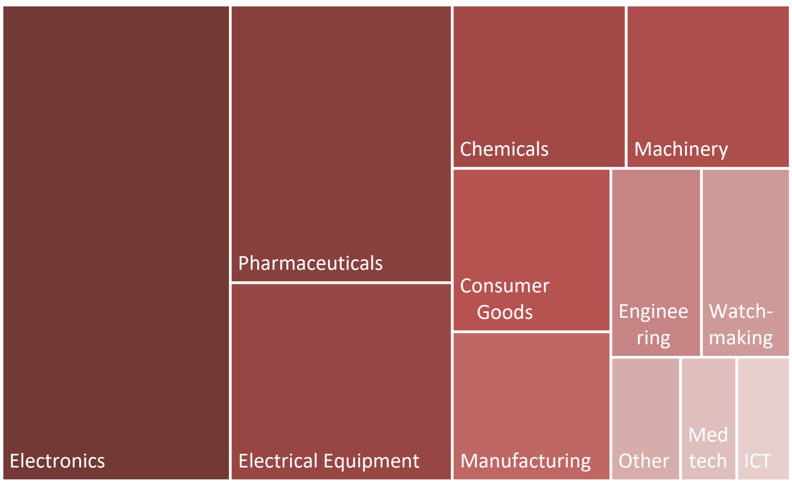
Cie Richemont	Management	424	348	64.90%
Garmin	Technology	399	885	0.00%
Firmenich	Flavors, Fragrance, Ingredient	396	912	77.50%
Givaudan	Flavors and Fragrance	391	1'078	47.10%
Georg Fischer AG	Manufacturing	340	494	47.90%
Landis+Gyr	Electronics	332	698	9.30%
SICPA Holding	Security ink	331	1'468	61.30%
Swiss Krono Group	Engineered wood products	301	890	34.20%
Buehler Group	Process engineering	300	511	48.00%
Geberit	Plumbing parts manufacturing	298	335	80.50%
Staeubli Holding	Mechatronics	294	778	13.30%
Credit Suisse	Financial services	294	572	0.70%
LafargeHolcim	Building materials	292	721	20.20%
Omya AG	Chemicals	290	2'550	79.70%
Hoerbiger Stiftung	Machinery	285	505	1.10%
Bobst Group	Machinery	284	605	62.00%
Metall Zug	Machinery	270	385	85.90%
Walter Reist Holding AG	Manufacturing and services	261	473	99.20%
University of Zurich	University	251	689	97.20%
Casale	Chemicals	242	571	78.50%
Swisscom	Telecommunications	216	457	96.80%
Swiss Center for Elect. & Microtech.	R&D Institute	200	411	97.50%
EMS-Chemie	Chemicals	194	917	91.80%
INFICON	Electrical Engineering	172	397	15.70%
Sensirion	Electronics/Electrical equipment	170	501	97.10%
Straumann	Medical devices	164	499	72.00%
Baumer Holding AG	Electronics	163	100	39.30%
SFS Group	Fastening systems and precision formed components	158	194	36.10%
Medela	Consumer goods	157	423	63.70%
RUAG Holding	Aviation, Space, Technology and Defense	157	224	28.00%
Rolex	Watchmaking	147	605	74.80%
Zehnder Group	Supply technology	141	143	31.90%
Ypsomed	Medical devices	138	656	97.10%

Advanced Digital Broadcast	Television, Telecommunications, Pay-TV, Broadband	135	120	2.20%
Conzzeta	Machinery	133	248	62.40%
Sonceboz	Electronics/ Mechatronics	131	317	45.00%
Meyer Burger	Machinery	127	208	37.00%
Eugster/Frismag	Home appliances	124	409	89.50%
Tecan Group	Electronics/Electrical equipment	124	313	54.00%
Patek Philippe	Watchmaking	121	105	91.70%
Komax Holding	Electronics/Electrical equipment	120	253	82.50%
Huber+Suhner	Electrical engineering	117	340	65.00%
Archroma Textiles	Chemicals	115	262	39.10%
Paul Scherrer Institute	R&D Institute	106	457	97.20%

Note: We have paid particular attention to report information that is as accurate as possible, but we cannot exclude the possibility that some errors in patent counts remain. †Although the company is headquartered in Basel, it is the subsidiary of the Chinese state-owned chemical company ChemChina, and Syngenta patents therefore belong to ChemChina.

Figure 3 provides additional background information on the patent portfolio of Swiss MNEs. It offers an aggregate view of the industry composition of the patenting activity of Swiss MNEs. Electronics is the largest industry in terms of patents, followed by pharmaceuticals and electrical equipment. Together, these three industries account for more than half of the patenting activity of Swiss MNEs. This figure includes data for the 65 MNEs discussed above; it does not consider the long tail of patenting activity by other Swiss companies. Furthermore, this figure should be interpreted as the technological composition of Swiss assignees, rather than the technological composition of Switzerland. As Table 2 shows, many of these patents were not invented in Switzerland.

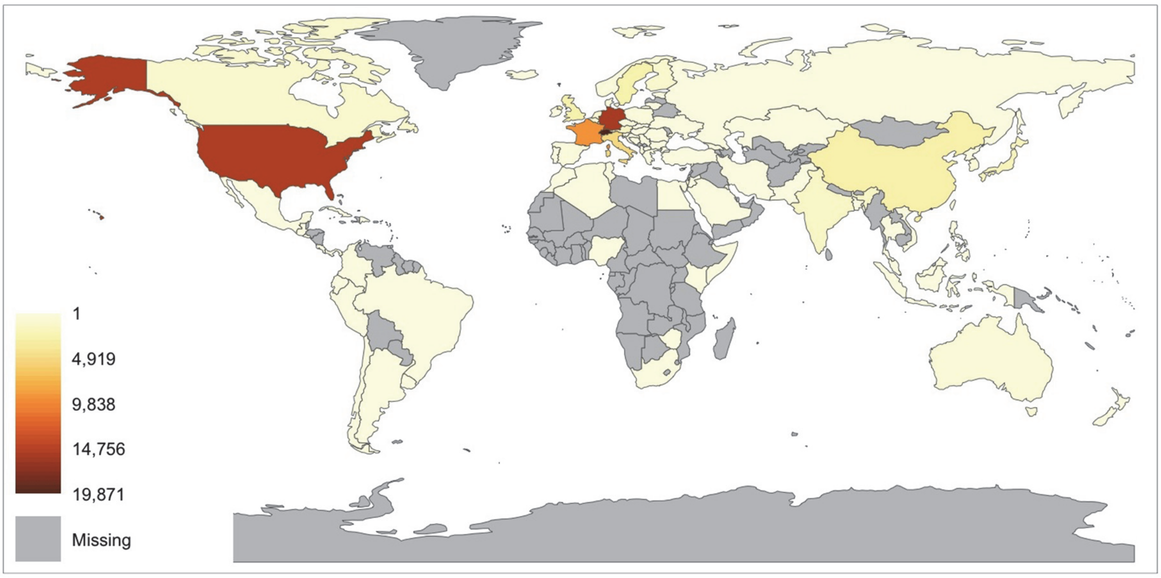
Figure 3. Industry Composition of the Patenting Activity of Swiss MNEs



Source: Data prepared by the IPI using the Patent Sight software.

Figure 4 depicts the origin of inventions by the 65 Swiss MNEs listed in Table 1, as assessed by the country of residence of inventors. In absolute terms, Germany, the United States and France are the three largest pools of talents that Swiss MNEs exploit. Overall, a quarter of inventions by Swiss MNEs are made in Switzerland (25.28 percent) and the European Union (27.11 percent). Two-thirds of inventions are made in the OECD (67.80 percent). Again, note that these data do not account for cross-border commuters who work in Switzerland, but live abroad (see Figure 5).

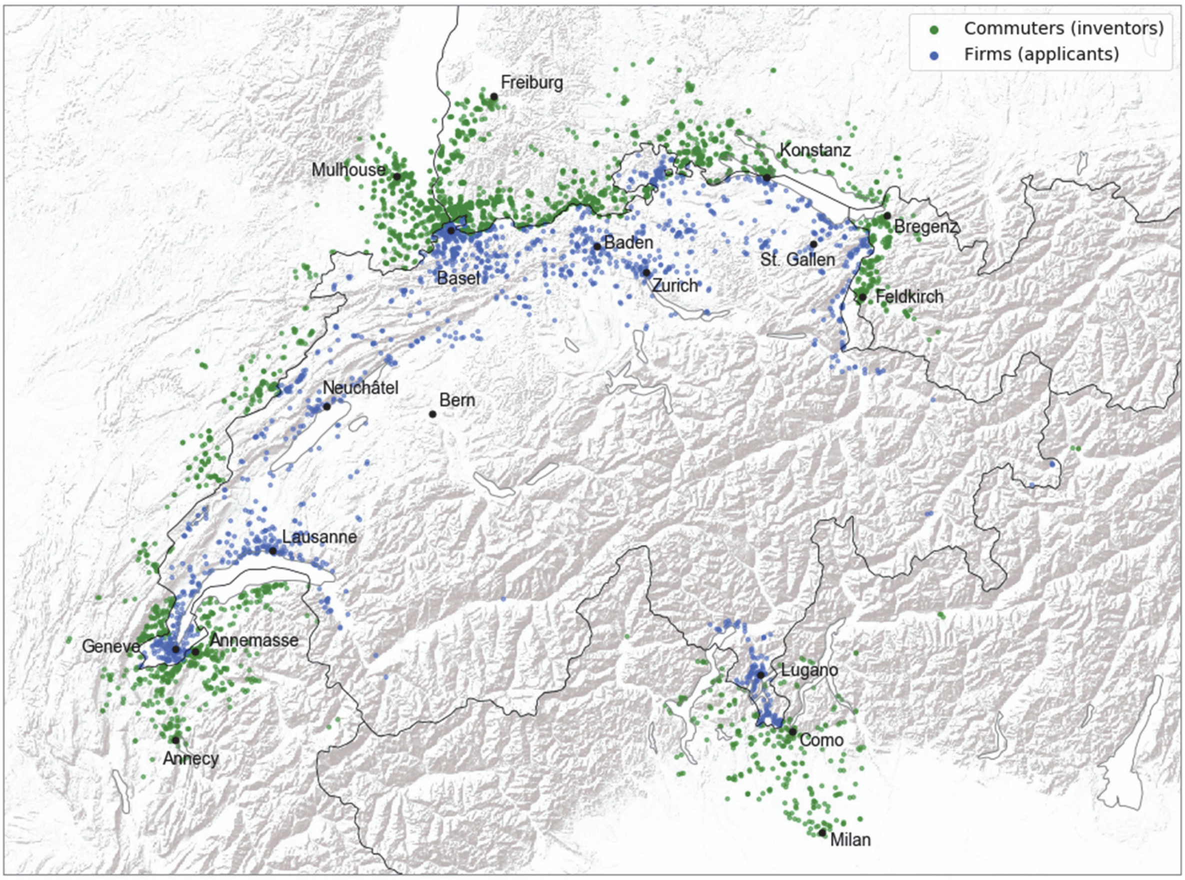
Figure 4. Origin of Inventions by Swiss MNEs



Source: Data prepared by the IPI using the Patent Sight software.

Figure 5 maps the location of inventors who commute to Switzerland (and, therefore, contribute to patent applications by Swiss-based applicants). To draw this map, we identified all inventors with a residence address outside of Switzerland who are listed on patents by applicants located in Switzerland. The map reports all instances in which the distance between the inventor and the applicant addresses is less than or equal to 50 km. As expected, the largest pools of commuters are located around the Basel and the Geneva area. Figure 5 is a useful reminder of the importance of foreign inventors in Switzerland, and of the limits of allocating patents to countries solely based on the residence of inventors (or applicants).

Figure 5. Commuters from Border Regions to Switzerland, within a 50 km Range between Inventor and Applicant Address



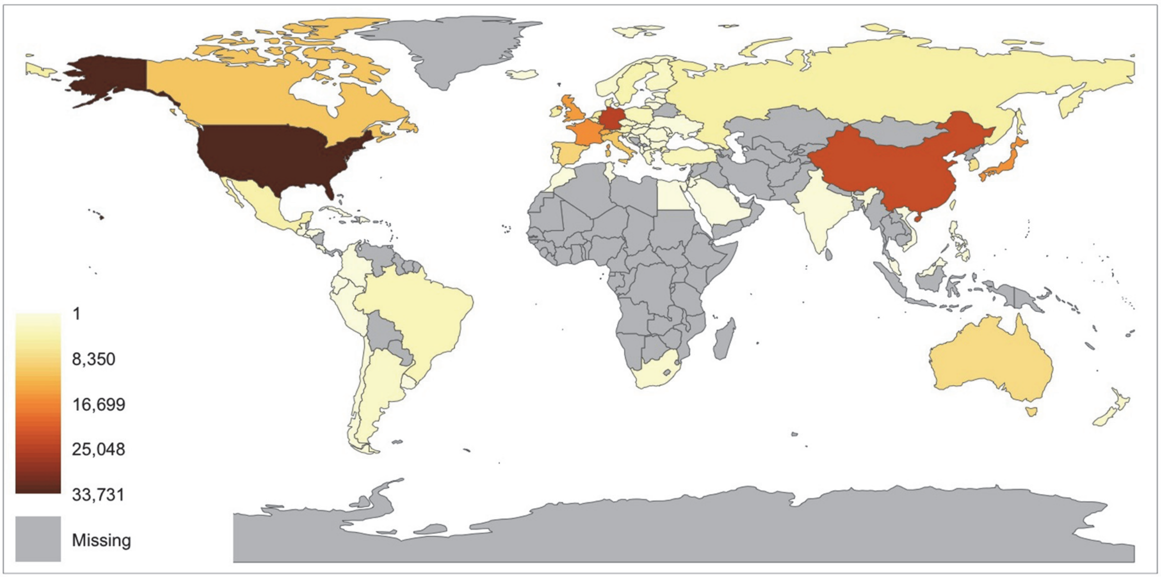
Source: Data prepared by KOF, based on a joint EPFL–ETH Zurich project funded by the Swiss National Science Foundation.

This section illustrates that the research activities of the largest Swiss patentees is highly international: for the majority of the firms considered, the majority of patents were invented abroad. It also documents that even for patents that are invented in Switzerland, a large number of inventors are commuters from neighboring countries.

Use of Foreign Patent Systems by Swiss Firms

Figure 6 depicts a heat map of countries where patent protection was sought by the Swiss MNEs from Table 2. This map provides an overview of the global reach of Swiss MNEs. Patents are territorial rights, and firms file for patent protection in foreign countries that are either important markets or important manufacturing centers. The United States is the jurisdiction that by far attracts the largest number of patents, followed by Germany and China.

Figure 6. Countries in which Patent Protection is Sought

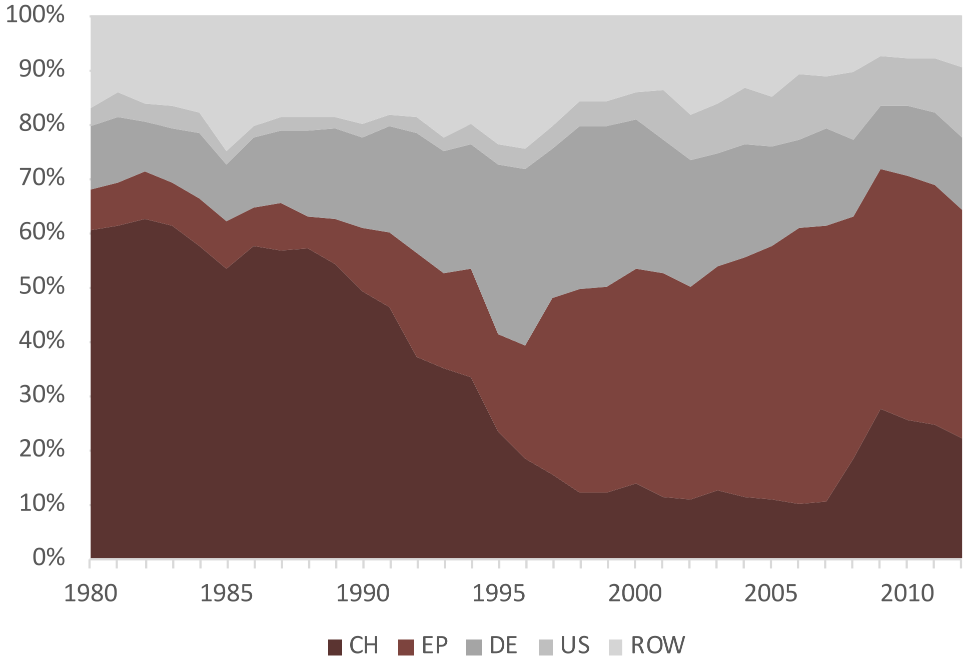


Source: Data prepared by the IPI using the Patent Sight software.

The figure above includes both priority and second filings. Priority filings are the first patent applications filed anywhere in the world to protect an invention. Second filings are subsequent applications filed in other jurisdictions to extend patent protection to those jurisdictions. Figure 7 provides a view of the destination of priority filings invented in Switzerland (that is, with an inventor residing in Switzerland, not correcting for cross-border commuters).

In the 1980s, the IPI attracted the majority of patent applications invented in Switzerland. The share of priority filings captured by the IPI has gradually declined, mainly to the benefit of the EPO. We believe that this trend is primarily the result of greater R&D globalization. Foreign companies that perform R&D in Switzerland are more likely to file at the EPO or the patent office of their home country (e.g., Germany or the United States). In addition, Swiss companies that target a global market may prefer filing directly at the EPO due to the greater geographic scope of protection it offers.

Figure 7. Patent Office of First Filing for Patents Invented in Switzerland



Notes: Data based on the PATSTAT database following the method developed in de Rassenfosse et al. (2013). CH: Swiss Federal Institute of Intellectual Property; EP: European Patent Office; DE: German Patent and Trade Mark Office; US: U.S. Patent and Trademark Office; ROW: Rest of the World.

Our interviews confirmed a global approach towards patenting among the companies we interviewed, from small start-ups to multinational enterprises. Companies mainly file patents at the USPTO and the EPO, and in the latter case usually seek validation of the EPO patent in Switzerland. Some of our interview partners systematically validate EPO patents in Switzerland because it is their historic home market. As several interviewees explained, they do not want competitors interfering with the home market because such interferences are highly visible for the top management, the press, and competitors. If start-up companies are successful, they often file patents for important jurisdictions around the globe, including Europe, North America and Asia. The Swiss patent system is of particular importance to the watch industry due to the large number of watch manufacturers in the country. Speedy issuance of patents is one reason why watchmakers almost systematically file through the IPI.

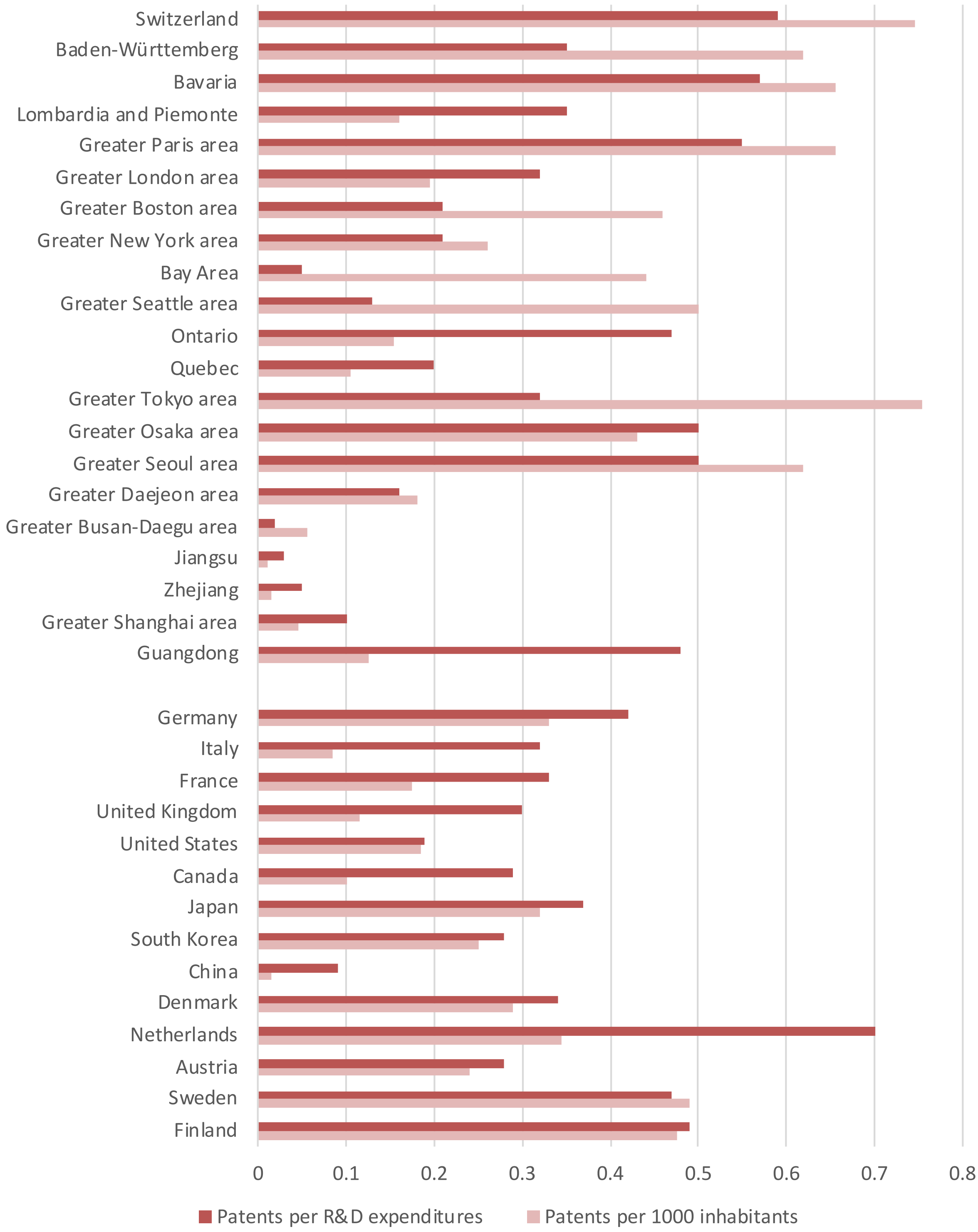
This section has illustrated the limited relevance of the Swiss patent system for Swiss patentees. The majority of patent applications for inventions invented in Switzerland are filed in foreign jurisdictions.

Swiss Firms are Leading in Emerging Technologies

This section presents data on the patenting performance of Switzerland compared to selected regions and countries. Figure 8 reports the average number of patents filed via the PCT route (international patents) and at the EPO (regional patents) over the 2008–2014 period (see Box 9). The patent count is normalized both by thousand inhabitants and by R&D expenditures.

In terms of patents per 1000 inhabitants, Switzerland is just behind the Tokyo metropolitan area and ahead of all other comparable regions. However, some of the performance of Switzerland is driven by a greater R&D intensity compared to other regions. Indeed, normalizing the patent count by R&D expenditures lowers the performance of Switzerland. In particular, this normalization reduces the gap with Bavaria and places the Netherlands in first position.

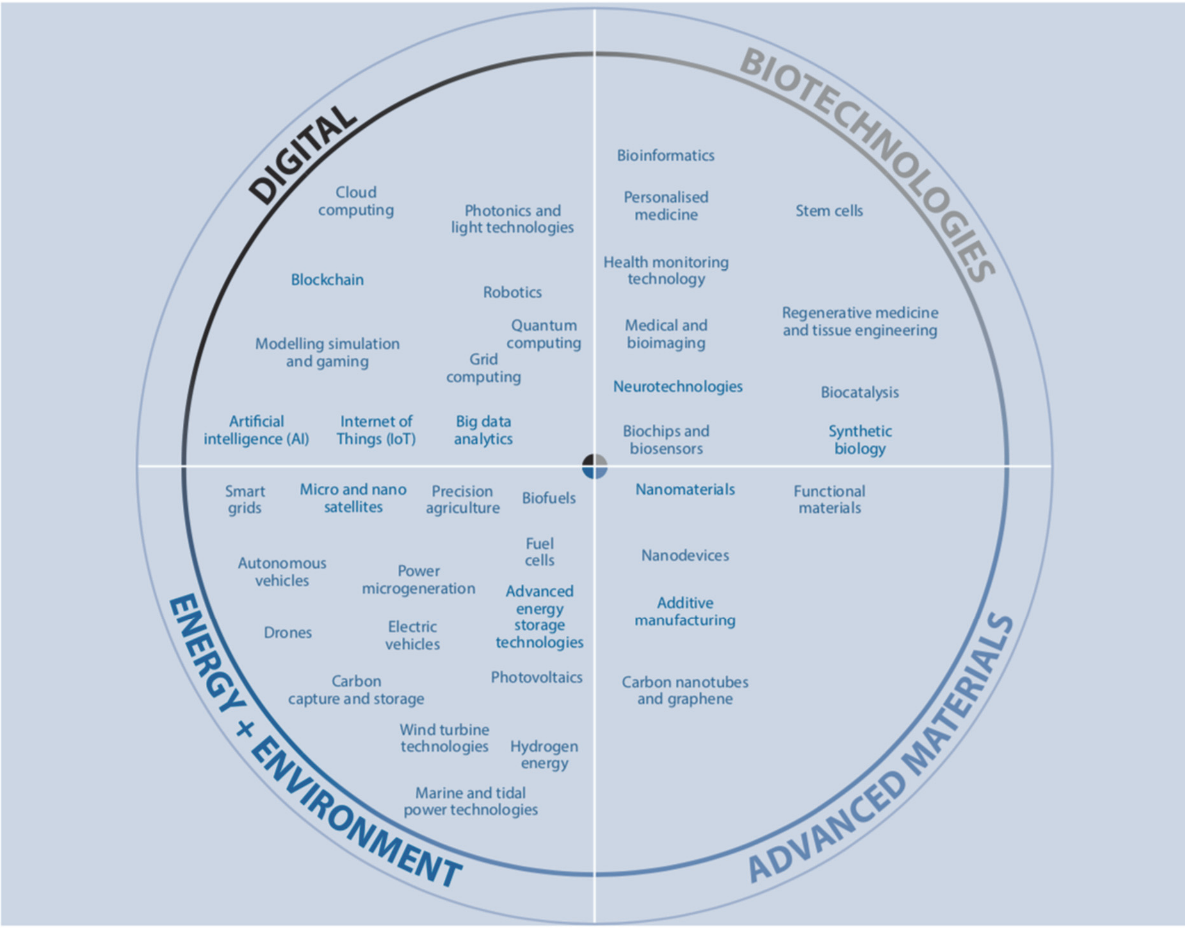
Figure 8. Patent Intensity for Selected Regions and Countries



Notes: Data for years 2008–2014. Data from Rammer and Trunschke (2018).

In order to identify emerging technologies, we rely on work by the OECD, which is the result of a foresight exercise carried out by national governments in Canada, Finland, Germany, the United Kingdom, the Russian Federation, and by the European Commission (OECD 2016). We also include insights from experts at the technology transfer offices at ETH Zurich and EPFL to produce our own list of emerging technologies. Figure 9 reports the result of the OECD exercise. Appendix B presents the list used in this report.

Figure 9. Forty Key and Emerging Technologies for the Future, OECD List



Source: OECD (2016:79).

It is usually straightforward to identify patents related to specific technologies because patents are classified into technology classes following the International Patent Classification (IPC) or the Cooperative Patent Classification (CPC). However, IPC and CPC technology classes are not well suited to identify emerging technologies. New technology classes in patents documents are created only once technologies have been well identified and delineated, that is, after they have emerged. Before that, emerging technologies may be allocated in patent documents to different technology classes at the same time, because of the inherent ambiguity regarding their nature or because they combine various technological domains together. A good example of this problem is additive manufacturing or 3D printing technologies. While the underlying technologies originate from the early 1980s, it was only in 2005 that a particular technology class for additive manufacturing inventions was added to the CPC (Bechtold 2016).

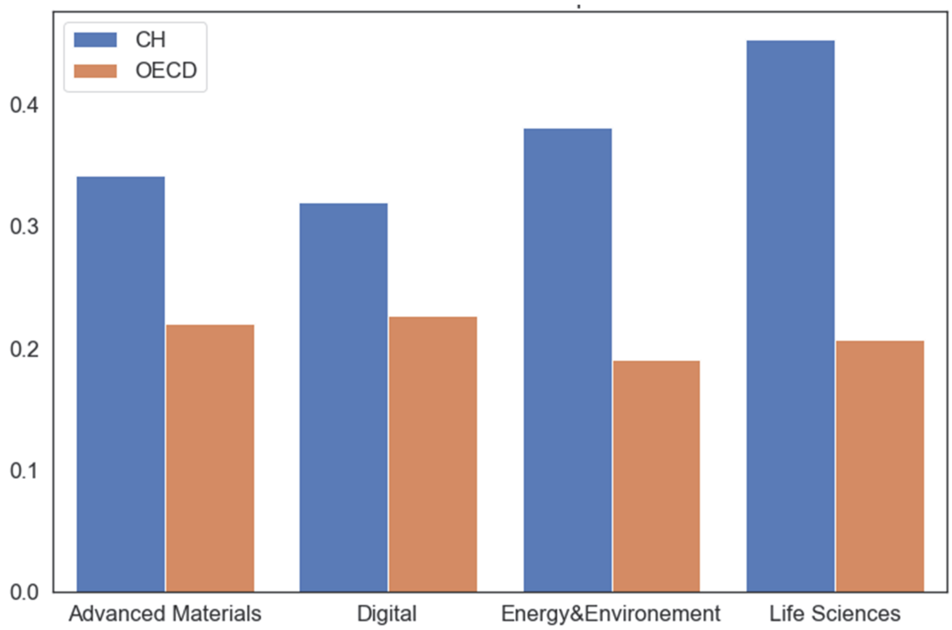
We rely on the technology classification made by WIPO. With the help of the IPI, we mapped WIPO technology categories associated to the following main topics: digital; energy and environment; life sciences; and advanced materials/manufacturing (see Appendix C). The IPI then searched the Patent Sight software for all patents related to these topics filed by companies in the OECD and in Switzerland.

Box 10. Emerging Technologies

Although the term “emerging technologies” if often used in innovation policy debates, it is difficult to define on a theoretical level. A recent survey of key innovation studies identified five common features of emerging technologies: their radical novelty, fast growth, coherence, prominent impact, as well as uncertainty and ambiguity in prospect (Rotolo et al. 2015).

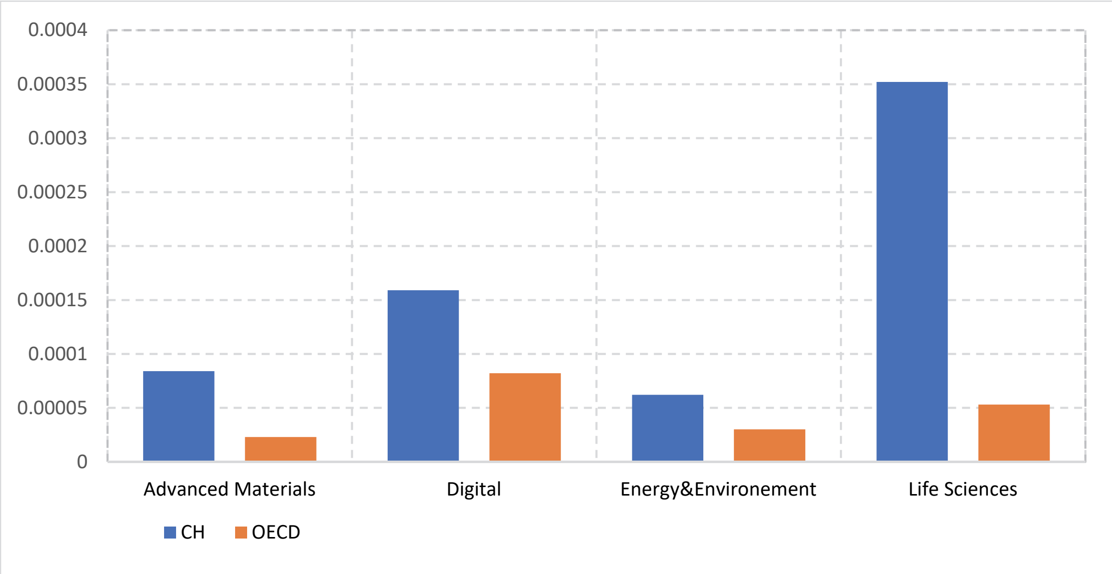
Figure 10 reports the proportion of world-class patents filed in the emerging technology areas for Swiss assignees and assignees in the OECD. A world-class patent is a patent with a “Competitive Impact” (which captures the relative business value of a patent and is measured by Patent Sight) in the top 10%. Switzerland has systematically had a larger share of world-class patents than other OECD countries. In relative terms, Swiss assignees in the aggregate have strong patent portfolios in emerging technologies. This figure is silent on the position of Switzerland in absolute terms. However, given the small size of the country, absolute numbers are not very informative. Figure 11 presents the number of world-class patents in emerging technologies per head of population. Switzerland appears particularly strong in life sciences. It is on par with OECD average regarding emerging technologies in the area of energy & environment.

Figure 10. Proportion of World-class Patents in Emerging Technologies



Source: Data prepared by the IPI using the Patent Sight software.

Figure 11. World-class Patents in Emerging Technologies, per Head of Population



Source: Data prepared by the IPI using the Patent Sight software.

This section has provided evidence that Switzerland is a patent-intensive economy, with a strong patent portfolio in emerging technologies.

5. Challenges for the Patent System and Way Forward

In recent years, the patent system has come under attack on multiple dimensions. In the information and communication technology industries, the public impression emerged that too many patents existed without providing a clear benefit to society. In these and other industries, opponents to the patent system argued that the system was not only unnecessary, but even harmful to innovation.

This Report is unable to find sufficient evidence, either theoretical or empirical, to support such radical claim on a general level. However, it is clear that the patent system is facing substantial challenges. Conceptually, discussions about the functioning of the patent system must distinguish between two opposite effects. First, does the patent system encourage innovation? Second, if it does not, does the patent system hamper innovation? On balance, in light of our interviews and the literature review, we are convinced that the patent system does encourage innovation in Switzerland. That is, Switzerland is better off with the current patent system than without. The question that follows is whether the current patent system provides the optimal environment for innovation. Answering this question is more challenging. Two features deserve particular attention.

First, from a theoretical viewpoint, the incentive effect of a patent is maximized with the issuance of *justified* and *clear* IP rights. “Justified” means that patents should be granted for inventions that would not have been developed without the patent system. Because it is difficult for patent examiners to identify such inventions, patent offices have set up inventive step thresholds to determine patentability. “Clear” means that the scope of the claimed invention should be well delineated in patent documents and there should be certainty regarding the validity of such rights. These elements would call for Switzerland moving to a full examination system. However, there are also costs associated with such a full examination system (see also Vaterlaus 2015). It is therefore not yet whether Switzerland need to move to such a system and how large the returns of such a change would actually be. As a matter fact, firms that want security over the validity of their patent rights currently file patents at the EPO. The question of whether to move to a full-examination system thus calls for a careful reflection of the place of the IPI in an integrated European system. Providing an assessment of this question would require a detailed analysis of the associated social costs and benefits, which far exceeds the scope of this Report.

Second, another way to improve the *net* benefits of the patent system is to reduce its cost. We must acknowledge that we still have limited knowledge on the welfare implications of the patent system. The claim that the patent system hurts innovation in some sectors has some truth to it, in particular in jurisdictions other than Switzerland. In a sense, the Swiss patent system is too small to affect the global innovation landscape. From the viewpoint of private actors, an obvious cost of the patent system is the cost of obtaining, managing and enforcing patents. This cost is exacerbated by administrative delays both during prosecution and litigation. The establishment of the Swiss Federal Patent Court is a welcome development in this respect.

Another recurring question is whether we should have a one-size-fits-all patent system or whether it should be tailored to various industries, technologies or actors. While legislators, courts and scholars have started to tailor the patent system to the most pressing needs of particular industries, the system is not fully versatile yet. For instance, as technological progress accelerates due to digitization, a system that needs several years to decide whether to grant a right or not is not appropriate for some technology areas such as ICT. We want to caution against the trend of tailoring. Tailoring is likely to increase further the complexity of the patent system, and it is notably difficult to anticipate the changing needs of the different industries. However, should further tailoring be implemented, we encourage the adoption of a “dynamic” design that lets applicants choose among a menu of options. A good illustration of such a dynamic design is the presence of renewal fees, which allows applicants to choose varying lengths of patent duration. The fast-tracking of patent procedures in exchange of higher fees is another illustration.

One of the most salient features of today’s innovation landscape is a shift towards digitization. This shift has implications for the patent office in various ways. We encourage the legislator to think about the implications of digitization on patent law and the patent system. First, digitization and communication enable production processes that are based on mass-scale customization. In a potential future world, consumers might print out physical objects with a 3D printer, either at their home or at a local copy shop; and hospitals may produce personalized medicine that is only prescribed to one patient or a small group of patients. Such developments would not only have an impact on distribution chains. They would also raise novel questions concerning incentives and liability regimes provided by the patent system (Lemley 2015; Bechtold 2016).

Second, several startups around the world are applying blockchain technology to IP contracts. This technology may disrupt the registration of some IP rights or licenses, in particular related to copyrights, and move some of the activities outside of the influence of the IP offices. At the same time, this technology offers interesting opportunities to improve the functioning of IP systems or to expand the offering of IP offices. The IPI should investigate these issues, and others, in a proactive manner.

Third, it is not clear whether the patent system is well-prepared for a world in which patents are rarely enforced and product cycles are becoming ever shorter. In a world in which collaboration in R&D between companies has become the norm and large-scale standardization efforts have opened up new markets, it is very important for companies to document their contribution in these collaborative efforts. In markets in which companies do not primarily need incentives to invent, but tools to document, the current patent system may not provide these tools in an optimal way. For this purpose, a cumbrous patent system with lengthy, costly procedures and—in many countries—a full examination of patent application may not provide an adequate solution. Rather, a faster, more flexible system that only registers rights—such as petty patents as they are granted in Germany, Italy or Japan—might be preferable. In fact, many of our interview partners were critical of excessive delays in the patent system. The time in the patent world is not the time in the business world, and company executives often do not understand why decisions regarding patents take so long. That said, we did not come across cases where product market introduction was delayed due to lack of formal patent protection.

We would like to encourage to IPI to be a role model on the “translation” of scholarly research on IP. Unlike many administrative offices, patent offices have the chance of having access to a community of scholars who study the IP system closely. While the

IPI is fairly well integrated in the community of IP scholars in Switzerland, we feel that it would benefit from stronger interactions with that community. Interesting topics are being addressed by IP scholars, and some of these topics are directly relevant to patent offices (e.g., the issue of fairness in the patent prosecution process, the marking statute, or the optimal setting of fees). In the long term, such interactions would improve the evidence base available to policy makers.

While Swiss universities and the IPI have invested significant effort and resources over the last years to facilitate knowledge flows from basic research up to the product level, more investment in training and counseling entrepreneurs seem desirable (Radauer & Streicher 2008; Keupp et al. 2009). On that front, we also recommend the implementation of reduced fees for universities and small and medium enterprises in a similar fashion as the USPTO. The demand for patent responds to change in price and these actors are presumably more price-sensitive than MNEs (de Rassenfosse and van Pottelsberghe 2012). However, policy makers need to account for the systemic implications of potential changes. Von Graevenitz and Garanasvili (2018) provides one illustration of such interrelating effects. They show that changing national patent fees affects the decision of firms to file patent at the national office vs. the European patent office, which has repercussions on the workload of these offices.

Finally, the idea that revenues from IP could be used to finance universities has been raised in some circles. We caution against such a move. In our opinion, IP-related revenues should be considered as a welcome addition to the budget of universities but should not replace structural funding. In fact, revenues derived from IP are highly unpredictable, and factoring such revenues into the core funding of universities would weaken the stability of their budget base. Furthermore, too strong a focus on IP may push universities to adopt a more restrictive approach to knowledge exchange, which could be detrimental to knowledge transfer.

6. Acronyms and Definitions

List of Acronyms

DPMA	German Patent and Trade Mark Office
EPC	European Patent Convention
EPO	European Patent Office
ICT	Information and Communication Technology
IP	Intellectual Property
IPC	International Patent Classification
IPI	Swiss Federal Institute of Intellectual Property
IPR	Intellectual Property Right
MNEs	Multinational Enterprises
OECD	Organization for Economic Co-operation and Development
PCT	Patent Cooperation Treaty
PRO	Public Research Organization
R&D	Research and development
SATW	Swiss Academy of Engineering Sciences
SERI	State Secretariat for Education, Research and Innovation
SMEs	Small and Medium-sized Enterprises
SPC	Supplementary Protection Certificate
USPTO	United States Patent and Trademark Office
WIPO	World Intellectual Property Organization

List of Definitions

This section defines key term mentioned in the Report. The definitions are adapted from the World Intellectual Property Organization.[11] Key terms missing from the list below are defined in the main document at their first occurrence.

Copyrights

Copyright is a legal term used to describe the rights that creators have over their literary and artistic works. Works covered by copyright range from books, music, paintings, sculpture, and films, to computer programs, databases, advertisements, maps, and technical drawings. The rights owner has usually the economic right to authorize or prevent certain uses in relation to a work or, in some cases, to receive remuneration for the use of his work. In Switzerland, copyright protection is obtained automatically without the need for registration or other formalities.

Designs

Designs, sometimes also called industrial designs or design patents, constitute the ornamental or aesthetic aspect of an article. They may consist of three-dimensional features, such as the shape of an article, or two-dimensional features, such as patterns, lines or color. Industrial designs are applied to a wide variety of products of industry and handicraft items: from packages and containers to furnishing and household goods, from lighting equipment to jewelry, and from electronic devices to textiles. Industrial designs may also be relevant to graphic symbols, graphical user interfaces (GUI), and logos. The owner of a registered industrial design has the right to prevent

[11] See in particular: http://www.wipo.int/trademarks/en/; http://www.wipo.int/designs/en/; http://www.wipo.int/copyright/en/; https://www.wipo.int/sme/en/ip_business/utility_models/utility_models.htm.

third parties from making, selling or importing articles bearing or embodying a design which is a copy, or substantially a copy, of the protected design, when such acts are undertaken for commercial purposes. In Switzerland, the protection conferred by designs extend to up to 25 years.

Petty Patents

A petty patent (also known as "utility model") is similar to patent protection, but the requirements of acquiring a petty patent are less stringent. While the requirement of "novelty" is always to be met, the "inventive step" requirement may be much lower or absent altogether. In practice, protection for utility models is often sought for innovations of a rather incremental character which may not meet the patentability criteria. In most countries where petty patent protection is available, patent offices do not examine applications as to substance prior to registration. This means that the registration process is often significantly simpler and fast. The term of protection for petty patents is shorter than for normal patents and varies from country to country.

Trademarks

A trademark is a sign capable of distinguishing the goods or services of one enterprise from those of another. It is used to protect a word or a combination of words, letters, and numerals, as well as drawings, symbols, three-dimensional features such as the shape and packaging of goods, non-visible signs such as sounds or fragrances, or color shades used as distinguishing features. Some trademarks are registered (sometimes denoted by the symbol ®) and others are not (sometimes denoted by the symbol ™). A trademark registration confers an exclusive right to the use of the registered trademark by its owner. This implies that the trademark can be exclusively used by its owner, or licensed to another party for use in return for payment. Registration provides legal certainty and reinforces the position of the right holder, for example, in case of litigation. The term of trademark registration varies across jurisdictions, but is usually ten years as in Switzerland. It can be renewed indefinitely on payment of additional fees. Trademark rights are private rights, and protection is enforced through court orders.

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Appendix A – Interview Questions and Partners

We have conducted semi-structured interviews with fourteen experts, as indicated in Table 3. We would like to thank the experts for having shared their insights.

Table 3. Interview Partners for this Report

Name	Position
Bonaccio, Silvio	ETH Zurich Head ETH Transfer
Braun, Axel	Hoffmann – La Roche Patent Department, Head International Developments
Clerc, Gabriel	EPFL Advisor to the President on IP matters
de Corte, Filip	Syngenta International Head IP Crop Protection
Metz, Grégoire	Décisions SA Chief Executive Officer
Meyns, Silke	ETH Zurich Head of Patents, Licenses & Software Licenses at ETH Transfer
Ravenel, Thierry	Ingénieurs Conseils en Brevets S.A./Swatch Group Ltd Managing Director
Schönberger, Daniel	Google Switzerland Head of Legal Switzerland & Austria
Schüller, Kees	Nestlé General Counsel Patent
Shokrollahi, Amin	Kandou Bus Chief Executive Officer
Stucky, Michael	ETH Zurich & Wyss Zurich Business Coach
Thémans, Michaël	EPFL Deputy of the Vice-President for Innovation
Thomsen, Peter	Novartis International Senior Patent Counsel IP Policy & Litigation
Wolfhard, Martin	Syngenta International Global Lead Counsel Seedcare

We had designed a generic question sheet which we used for all interviews. Not all interviewees were knowledgeable on all questions, and we sometimes asked additional questions to specific interviewees.

- How important is patent protection (and other kinds of IP protection) for the commercial success of your company?
- What role does the Swiss patent system play for your company, compared to foreign patent systems?
- In your opinion, does the Swiss patent system grant enough / too little / too much protection?

- If you compare protection through the patent system to other means to position your company in competition (lead time, secrecy, complementary sales & services, complementary manufacturing), how important is patent protection for your company?
- If your company is registering patents, what are the main reasons for doing so: measuring performance, generate licensing revenue, use in negotiations, prevent lawsuits, prevent copying of technology, patent blocking, enhancing reputation?
- How do you gather information about the products and R&D of your competitors: patents, publications, meetings/conferences, informal exchange, hiring employees, licenses, joint ventures, contracts, analyzing competitors' products, trade associations, being part of a regional cluster?
- To what extent does the patent system facilitate or hinder spillovers between market participants?
- From your perspective, are there downsides of the patent system for your company and for the markets in which your company operates?
- At least in general, the patent system does not distinguish between different kinds of industries. Do you think this is a good idea?
- Some countries provide petty patents, in additional to regular patents. Do you think Switzerland should also provide for petty patents?
- Have there been cases where your company actively decided to not patent a product, but to make the invention publicly and freely available?
- What effect will the envisioned Unitary Patent and the Unified Patent Court have on Switzerland?
- What role does (and should) the patent system play in financing universities?
- To what extent does the patent system provide sufficient protection for SMEs? What are the major hurdles for an SME to protect his products through the patent system?
- To what extent does the patent system provide adequate protection in fast-moving industries?
- What is the proportion of R&D investments that is put into patenting?
- How important is the trading of patents (buying and selling)?

Appendix B – List of Emerging Technologies

Theme	Topics	Specific terms
Digital	Artificial intelligence	Big data analytics, cognitive computing, machine learning and neural networks
	Blockchain	Smart contracts
	Computing	Cloud computing
	Cyber security	
	Fintech	Crypto currency
	Internet of things	Connected machines, data networking, M2M
	Robotics (autonomous systems)	Drones, soft robots, *social robots*
	Industry 4.0	Augmented reality, big data analytics, gamification, modelling and simulation, process simulation, smart sensors
Energy and environment	Agriculture	Precision farming
	Mobility	Autonomous vehicles, e-mobility, electric vehicles, mobility concepts, sharing concepts
	Smart city	Mobility concepts, sharing concepts, smart houses, *smart lighting*
	Energy management	Advanced storage technologies, batteries, energy efficiency, energy transformation, smart grids
	Energy production from renewable sources	Geothermal energy, hydrogen energy, photovoltaics, wind turbine technologies, *solar thermal, carbon capture, biomass*
Life sciences	Medical and bioimaging	
	Microbiota-based therapeutics	
	Regenerative medicine and tissue engineering	Gene editing, gene therapy, stem cells
	Systems biology (incl. drug targeting)	Artificial intelligence, big data analytics, gene editing, gene therapy, health monitoring technologies, lab-on-a-chip, stem cells
	Personalized medicine	
Materials / manufacturing	Advanced manufacturing	3D printing materials, additive manufacturing, process automation
	Advanced materials	Functional materials, smart textiles, *CNT/graphene, composites*
	Micromechanics, *Nanomechanics*	*Microsensors*
	Photonics and light technologies	

Appendix C – Construction of Emerging Technology Classes

The following WIPO categories were used to construct the emerging technology classes.

Energy & Environment	Life Technologies
Energy_Battery Lithium_08_18, Energy_BiomassFermentation_03_18, Energy_Fuel Cells_02_18, Energy_OrganicPerovskitTandemPhotovoltaic_07_18, Energy_SmartGrid_09_18, Energy_Wind Energy_01_18, Systems_Autonomous Driving_08_18, Systems_CarbonCapture_12_17, Systems_Cosmonautics_06_18, Systems_Drone_02_18, Systems_Electro&HybridVehicles_06_18	Digital_MedtechDigital_01_18, Life_Bioimaging_RadiationDiagnosis_03_18, Life_Bioprinting_07_18, Life_Biosensor Microfluidic LabonaChip Bioprinting_07_18, Life_Biotech_Red_09_18, Life_Biotech_White_09_18, Life_DrugDiscoverySystemsBiology_03_18, Life_MedicalBionics_03_18, Life_MedicalWearable_03_18, Life_Neuroprothesis_03_18, Life_ProteinEngineering_09_18, Life_Virus Antibody_04_18
Digital	**Advanced Materials**
Digital_3DImageModelling_03_18, Digital_Blockchain_09_18, Digital_Datasecurity_09_18, Digital_IoT_09_18, (Smart City, Smart House, Smart Grid, M2M), Digital_Fintech_01_18, Digital_ElectronicGaming_01_18, Digital_MachineLearningAI_05_18, Digital_Process Automation_05_18, Digital_QuantumComputing_08_18, Systems_Photonics_01_18, Systems_Robotic _08_18 (w_ B60 Cars)	Material_AdvancedMaterials_07_18, Material_CarbonGraphene_07_18, Material_Nanomaterial_01_18, Systems_AdditiveManufacturing_cleaned_09_18, Systems_Nanostructures_07_18

The following WIPO categories were not assigned:

Measurement
Medical Technology
Organic Fine Chemistry
Handling
Electric Machinery Apparatus Energy
Pharmaceuticals
Computer Technology
Basic Materials
Machine Tools
Special Machines Other