Mastering multiple complexities – a rising challenge for Swiss innovation models

Final Report on the contract "Erstellung einer Studie zum Rückgang der Innovationsaktivitäten der Schweizer Unternehmen"

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1. Introduction

Switzerland is one of the most competitive countries in the world. Commercially successful innovation activities are an essential part of this achievement. However, for two decades, Swiss innovation surveys have shown a significant decline in the number of R&D active companies among all companies and of the proportion of companies reporting an innovation (product or process innovation).[1] The declining number of R&D active companies has also been observed in other innovative countries, such as Germany, while again in other countries, an opposite trend has been found with more companies being engaged in R&D (e.g., Finland, Netherlands) (Wörter & Spescha, 2020). Such developments require more in-depth analyses, especially for a country like Switzerland, where prosperity is strongly based on companies' innovative capacities. This overall decline is mainly a reflection on the changes in SMEs. It raises several questions which should be answered in this project.

First, we explored what megatrends or contextual changes in the technological, regulatory, or market environments have affected the innovation activities of SMEs and the larger companies. To a large degree, these contexts depend on the industries in which they are active. Therefore, we tried to group industries and then collected qualitative information from industry experts (see below, section 3).

In a second step, we looked at whether the SMEs' innovation models have changed over time as a result of the contextual changes. For instance, whether innovation activities were less related to internal R&D activities, whether the importance of external innovation partners had changed, or whether the importance of non-technological innovations, like organizational, marketing or business model innovations, which rely less often on R&D, had grown. Did a possible shift in non-technological innovations have an influence on the importance of universities or other research organizations who were collaboration partners of SMEs in innovation projects? Further, did the relative importance of other partners increase?

The third focus of the project was on the innovation policy implications of the identified dynamics. What adaptations of the institutional framework or innovation funding approaches and conditions in SMEs did industry stakeholders suggest? What policy-related bottlenecks to innovation did they perceive? Did the contextual dynamics and innovation model changes require new eligibility criteria, new recipients of funding or new procedures for awarding funding?

The report addresses these questions in two ways:

a) by conducting further analyses of the existing data both from Swiss innovation surveys and other sources (section 2 "Background"), and
b) by conducting hearings with industry and innovation experts (sections 3-5).

The method of hearings is briefly described in section 3. Section 4 summarises the results of the conducted hearings and section 5 teases out the overarching salient features of contextual dynamics, changes of innovation models, and suggestions for innovation policies made during the hearings.

Section 6 formulates tentative implications for Swiss innovation policies and further research needs. The analyses conducted so far have an exploratory character. They do not yet allow any generalisable and conclusive statements to be made on the research questions and should not be regarded as a basis for far-reaching innovation policy decisions, but rather as indications of possible bottlenecks and obstacles that would have to be addressed or removed for effective and efficient innovation activities and productivity growth in the Swiss economy in the future.

[1] In the most recent period under review, the share of R&D-active companies has increased again (see Spescha & Wörter, 2022). The next surveys will inform us about the persistence of this development.

2. Background

Over the last 20 years, the environment for innovation activities has changed significantly. In the following text, we present some key features of this change which could be identified based on extensive empirical data. In a first step, we refer to international innovation rankings and their indicators; in a second step, we allude to the concentration of innovation and R&D activities in Switzerland. Furthermore, we observe a stagnation of the average commercial success of innovative products and services, which is mainly driven by incremental innovations. This indicates a change in the focus of innovation. We see that the number of companies with external R&D activities has been growing. We also observe that especially smaller companies are increasingly commissioning other institutions and companies to develop innovations. As expected, digitalisation capabilities are positively related to the economic success of more radical innovations. Finally, we see some evidence of a decline of productivity growth in Switzerland, which points to growing difficulties in the successful commercialisation of innovations.

Switzerland is one of the most innovative countries.

Switzerland is one of the most innovative countries in the world. According to the "Global Innovation Index", it ranks first for the 12th consecutive year (see WIPO 2022; Figure 1). It is particularly strong in "knowledge and technology outputs", such as knowledge creation (e.g., number of patents) and knowledge diffusion (e.g., production and export complexity), as well as in "creative outputs", such as the density of country code top-level domains. Surprisingly, however, the country does not perform as well on high-tech exports (% of trade), creation of new businesses, labour productivity growth and ICT service exports (% of trade) (see WIPO, 2022).

Figure 1: Global Innovation Index Ranking

Country/economy	Overall GII	Institutions	Human capital and research	Infrastructure	Market sophistication	Business sophistication	Knowledge and technology outputs	Creative outputs
Switzerland	1	2	4	4	8	7	1	1
United States	2	13	9	19	1	3	3	12
Sweden	3	19	3	1	13	1	2	8
United Kingdom	4	24	6	8	5	22	8	3
Netherlands	5	4	14	14	18	10	5	10
Republic of Korea	6	31	1	13	21	9	10	4
Singapore	7	1	7	11	4	2	13	21
Germany	8	20	2	23	14	19	9	7
Finland	9	11	8	3	17	5	4	18
Denmark	10	9	10	5	15	15	12	14
China	11	42	20	25	12	12	6	11
France	12	18	15	17	10	17	15	6
Japan	13	21	21	12	9	8	11	19
Hong Kong, China	14	10	13	6	2	27	60	5

Source: WIPO 2022

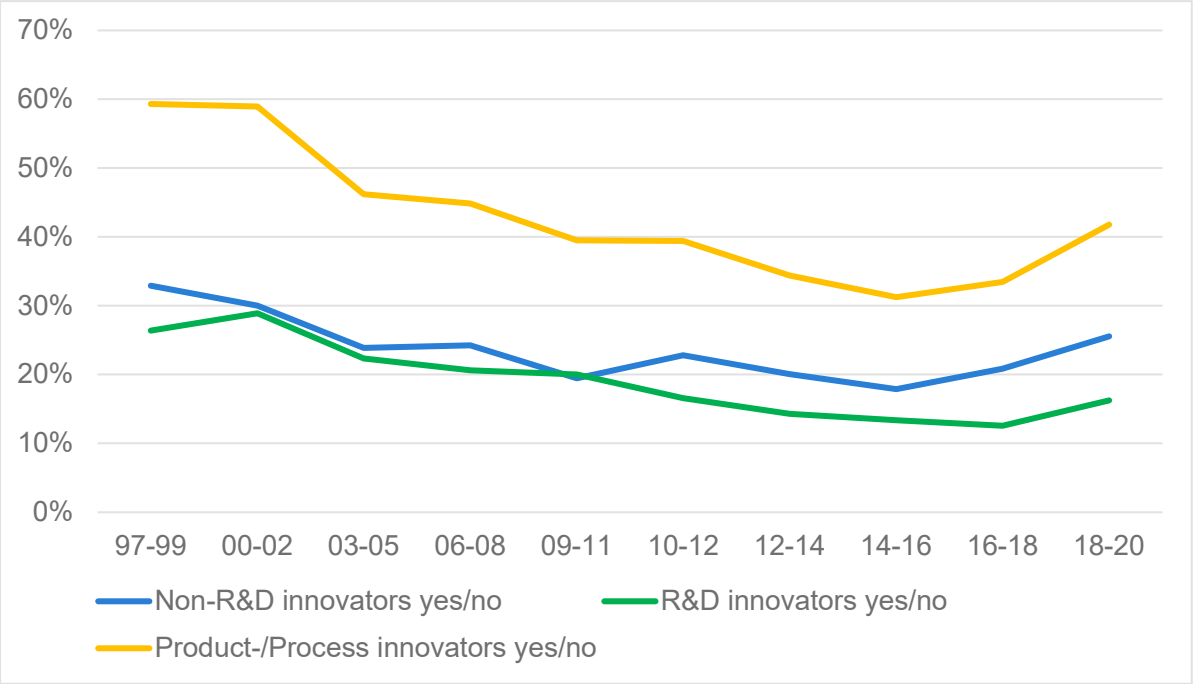
Innovation activities are more concentrated in the Swiss economy

We see a mixed picture when we look at the development of indicators that are immediately related to the innovation input and innovation output of companies. Examples of such indicators are the fraction of R&D active[2] companies and the R&D expenditures on the input side as well as the fraction of innovative companies and the sales share of innovative products and services on the output side.[3]

[2] Definition R&D activities: Research includes basic research and research directly related to specific applications (applied research). Development includes the use of known scientific knowledge to produce new or improve existing products and processes.

[3] Definition innovation: Product/service innovations are new or significantly improved products or services whose components or basic features (basic technical features, integrated software, usage characteristics, user-friendliness, availability, customer benefits, design) differ noticeably from the products and services previously offered by the company. No product innovations

Figure 2: R&D/non-R&D innovators (in % of all companies)



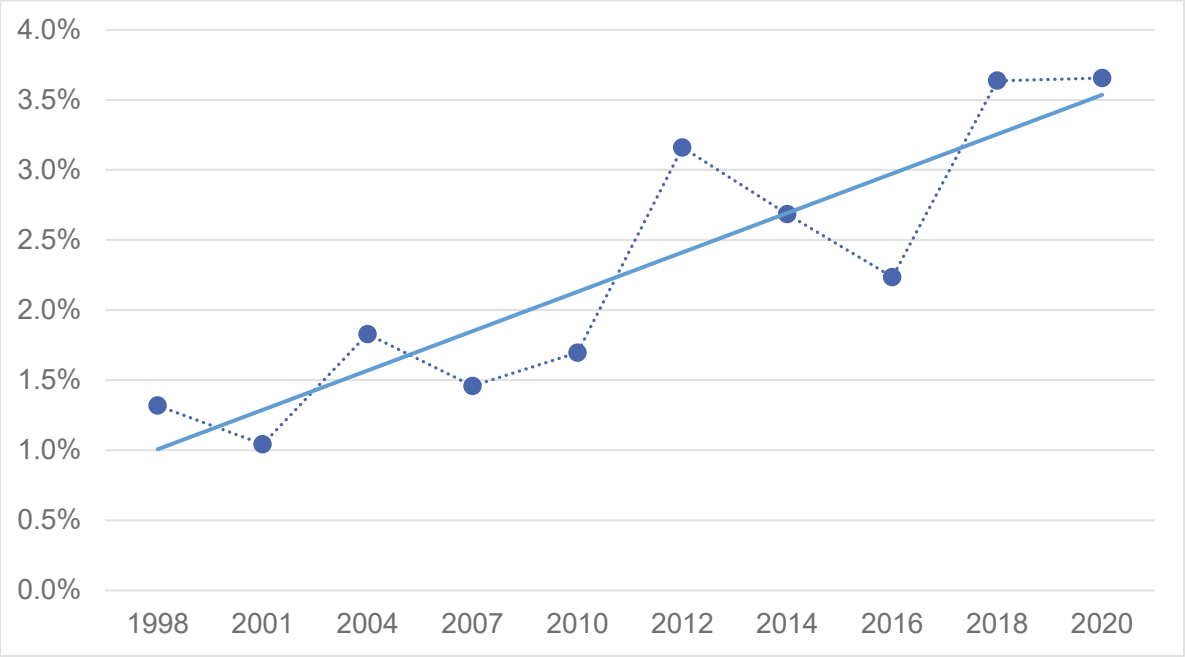
Source: KOF Innovation Survey 2020. Calculations of the authors based on all companies with more than 5 employees (full-time equivalents). Please note that the share of companies with R&D (R&D innovators) and the share of non-R&D innovators (non-R&D innovators) sums up to the share of product/process innovators. The timeline refers to time periods in accordance with the corresponding question in the survey.

Figure 2 shows the development of the number of innovating companies (product or process innovators), the number of R&D-active and innovating companies and the number of innovative companies without R&D activities starting with the period 1997-1999. The number of innovators and R&D-active companies has declined significantly. In the most recent observation periods, only an increase in the proportion of innovators and R&D-active companies can be seen. Nevertheless, today there are far fewer innovators in Switzerland than two decades ago. However, the remaining current R&D-active innovators invest much more in R&D relative to turnover than they did two decades ago. Figure 3 shows the development of the share of R&D expenditure of turnover of the innovating companies (R&D intensity). Taking the results from Figure 2 and Figure 3 together, there is a clear concentration of R&D activities in Switzerland.[4]

are purely aesthetic modifications of products and services. The mere sale of innovations produced by other companies is not a product innovation. (Trade: Product innovations are innovations in distribution, but not innovations in the traded goods).

[4] For the reasons why Swiss companies stopped doing R&D and productivity growth effects see König et al. (2022).

Figure 3: Sales share of R&D-expenditures (in % of all sales)

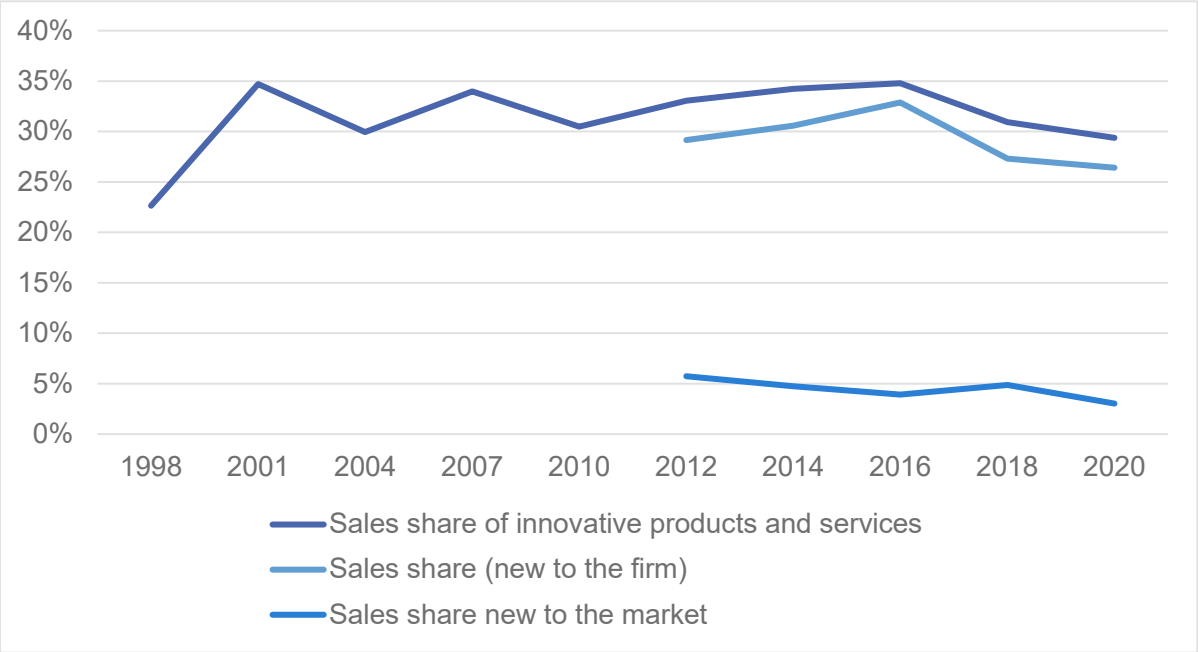


Note: The trend line indicates the general direction of the development (linear least square estimation).
Source: Spescha and Wörter (2022).

Knowing the background of these general trends, the number of non-R&D innovators, i.e., companies developing innovative products and processes without R&D activities, remained relatively constant over time. This suggests that the entry and exit dynamics in innovation markets seem to be related to the entry and exit dynamics in the R&D markets. Companies that exit R&D markets are likely to exit innovation markets as well. During the last three observation periods, however, an increase in the share of non-R&D innovators can be observed, while the share of R&D-active innovators decreased. Since R&D-based innovations are more often associated with advanced innovations (e.g., innovations that are new to the market) and non-R&D-based innovations with incremental innovations (e.g., innovations that are new to the company), these results indicate that the Swiss economy has tended to move towards more incremental innovations in recent years.

Figure 4 shows the development of the commercial success of innovations to be mainly driven by incremental innovations. Since 2001, the average sales share of innovative products and services of innovative companies with more than five employees has fluctuated between 30% and 35%. Since 2012, the average economic success has been fluctuating strongly along with the sales contributions of innovations that are new to the firms (incremental innovations) and less with the contributions of innovations that are new to the market (radical innovations). Nevertheless, it is remarkable how companies have managed to keep the average sales share of innovations high, even though many companies have stopped their R&D and innovation activities. This shows that the remaining innovative companies have managed to develop innovations with a relatively high market penetration.

Figure 4: Sales share of innovative products and services (in% of all sales)



Source: Spescha and Wörter (2022)

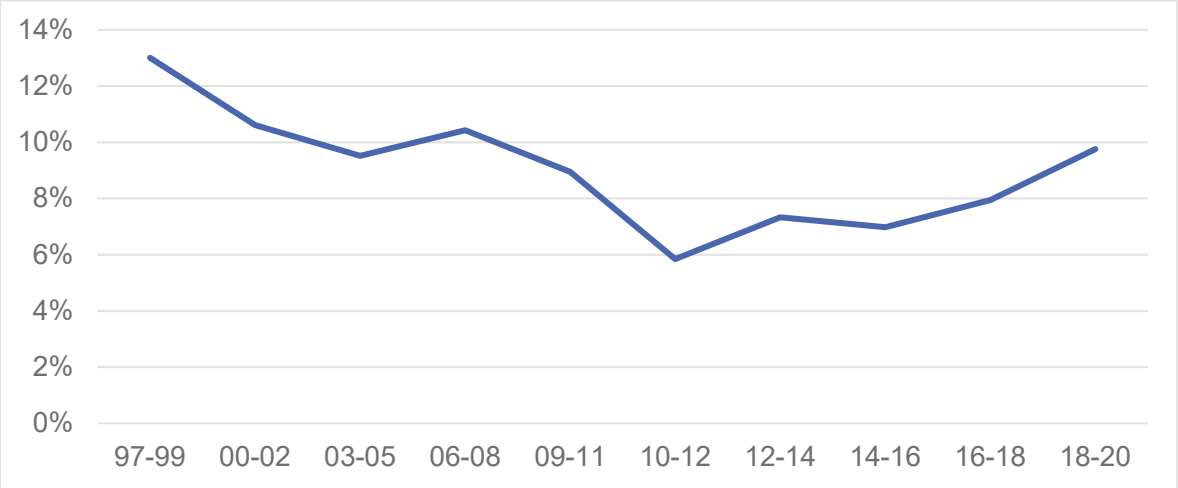
More extramural R&D, more external innovation

The statistical results mentioned above raise the question of how companies organise their innovation activities in order to innovate successfully. Some general developments are presented below.

More external R&D

The number of the R&D active companies which contracted external parties (companies, public research institutions, etc.) for R&D activities decreased considerably between 1997-1999 and 2010-2012. During this time, R&D-active companies focused more on internal R&D activities (see Figure 5). On average, the number of R&D active companies with external R&D contracts decreased by 50%. However, the picture has changed since then. More and more R&D-active companies are now awarding R&D contracts. During the last period surveyed, that number increased to 10%.

Figure 5: External R&D activities (yes/no) (in % of all companies)



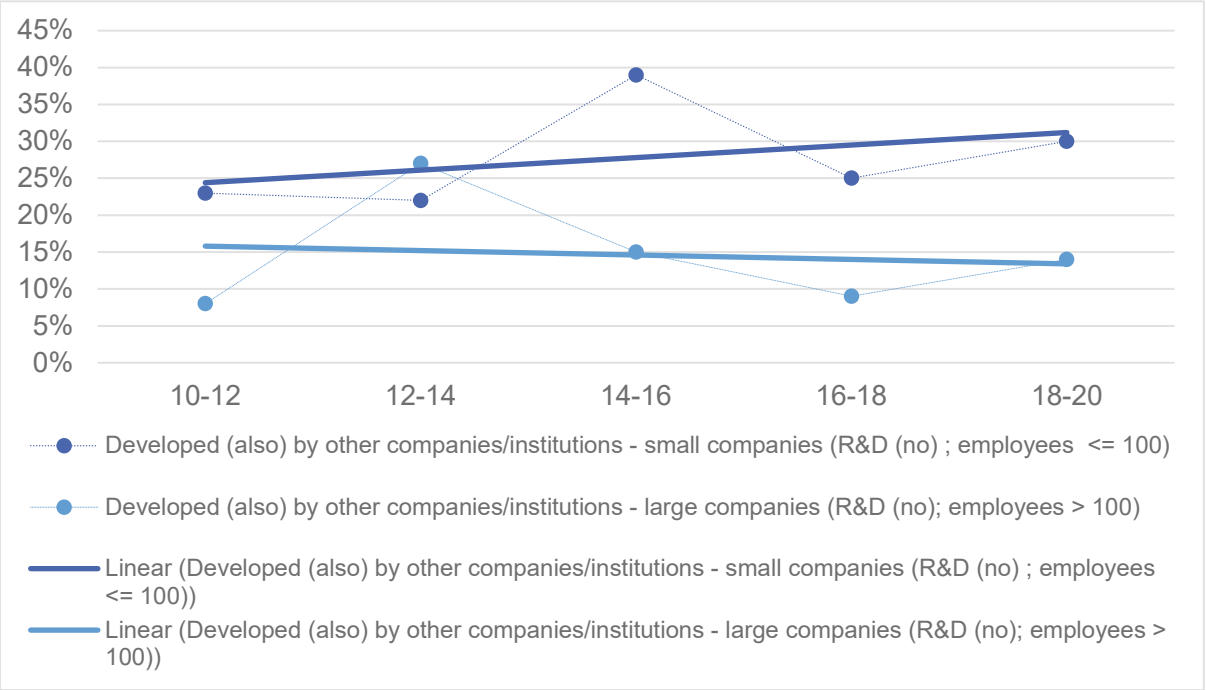
Source: Spescha and Wörter (2022). The timeline refers to time-periods which relate to the corresponding question in the survey.

External Innovations: Introduced product innovations are more frequently developed by other companies/institutions.

Figure 6 shows the results of smaller innovative companies which do not carry out R&D activities themselves and have less than 100 employees. The number that reported that their innovations were mainly developed by other enterprises/institutions has grown by 5% since 2013 and reached 30% in 2021.[5] A similar development – an increase by about 5% between 2013 and 2021 – can be also observed for larger companies with more than 100 employees. However, the number of companies introducing product innovations developed by other companies/institutions is about 15% lower. Furthermore, the trend over time for smaller companies is slightly positive. There is, though, a high degree of variability in this development and the trend can differ between industries. Still, the data suggests that smaller companies may have more problems providing the necessary amount of (increasingly diverse and deep) skills themselves to remain innovative and competitive. It can be particularly difficult if knowledge requirements change constantly, e.g., because digitalisation has become increasingly more important for innovation activities (see Spescha and Wörter 2020, p. 56) or because knowledge from other disciplines is required, e.g., to make the innovation more environmentally friendly.

[5] The specific survey question was: Who developed the introduced product innovations (multiple answers possible)? Response options: a) Mainly other companies/institutions. b) Your company together with other companies/institutions. c) Mainly your company. d) Your business by adapting products from other businesses. It is likely that there are significant differences between sectors.

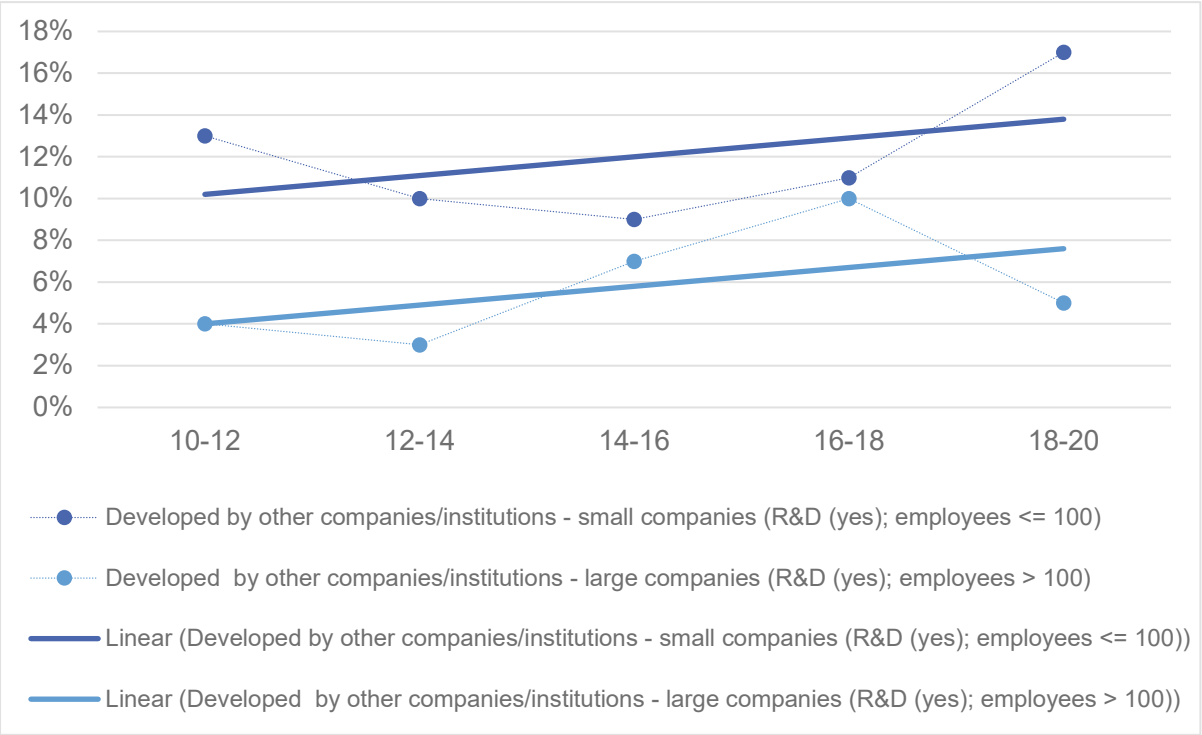
Figure 6: Non-R&D innovators: Innovative products developed by other companies/institutions (non-exclusive categories)



Source: KOF Innovation Survey. Own calculations based on innovative companies. The timeline refers to time-periods in accordance with the corresponding question in the survey.

Figure 7 presents the same phenomenon, the incorporation of externally developed innovations in R&D active companies. Again, we see a positive trend for smaller companies with less than 100 employees. Approximately 17% of the R&D active companies stated that their new products or services were mainly developed by other companies or institutions in 2018-20. Although the difference between small and larger companies increased 2018-20 compared to 2016-18, the average development over time was similar for larger companies. The level of having innovations developed by others, however, was lower in larger companies. This indicates that smaller R&D active companies have a greater need to find competent partners for the development of new innovative products and services than larger companies. Similarly, non-R&D active companies often lack in-house competences and the financial means to adapt to a changing innovation environment, where new technologies increasingly shape the business models and time-to-market becomes more and more important.

Figure 7: R&D innovators: Innovative products developed by other companies/institutions (non-exclusive categories)



Source: KOF Innovation Survey. Own calculations based on innovative companies. The timeline refers to time-periods in accordance with the corresponding question in the survey.

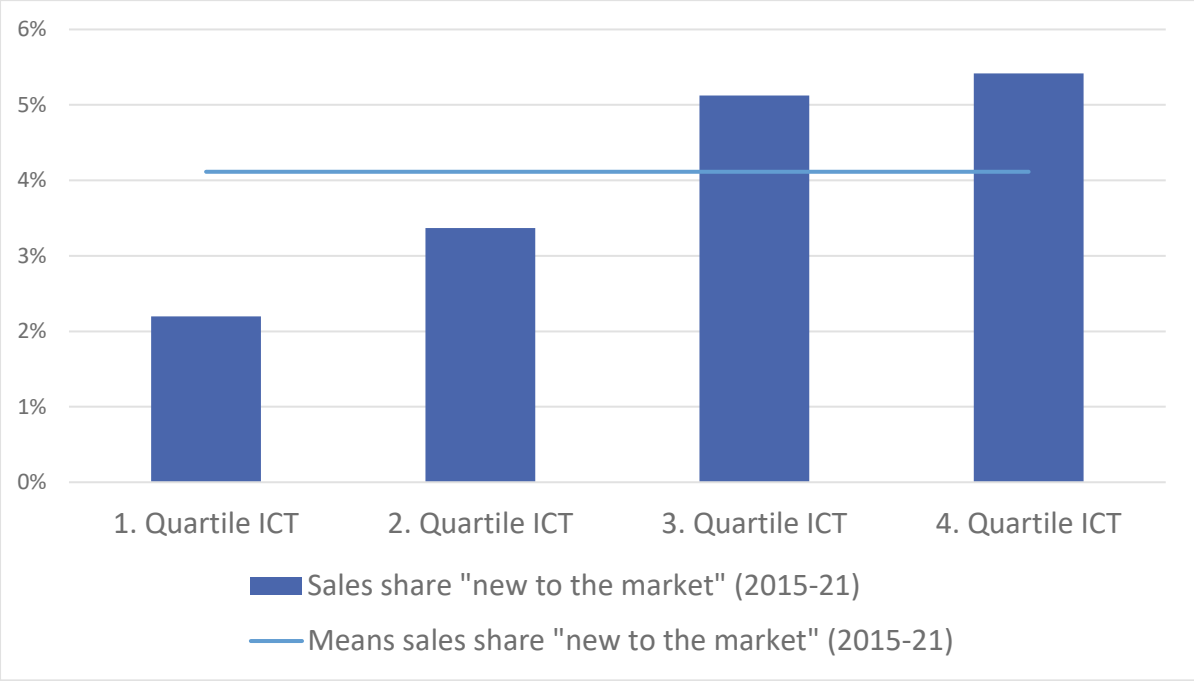
Investments in digital technologies have become more important for more advanced innovation

Figure 8 shows the commercial success of products that were "new to the market" for the period 2015-2021 (average sales share). The companies are differentiated by the levels of ICT (Information and Communication Technology) investments[6] – measured by their share of fixed capital investments also between 2015-2021. We built four ICT-investment categories: companies with the lowest ICT-investment shares (1st quartile: these are the 25% with the lowest ICT-investment shares), companies with medium to low ICT-investment shares (2nd quartile), companies with a medium to high ICT-investment share (3rd quartile) and companies with a high ICT-investment share (4th quartile).

The resulting empirical pattern is quite revealing. Companies with an above median ICT-investment share (3rd and 4th quartiles) develop innovative products and services that are commercially more successful compared to those companies with an ICT investment below the median level. Hence, digital investments not only have the potential to increase the efficiency of companies, but they are also positively related to the commercial success of more advanced innovations. This finding emphasizes the increasingly important role digital technologies play when advanced, more radical innovations are developed.

[6] ICT-investments refer to investments in hard- and software.

Figure 8: Sales share of innovative products/services "new to the market" and ICT Investments (Quartiles)



Source: Spescha and Wörter 2022.

3. Hearings: method and data

As a first step of our investigation how companies have adapted their innovation models and how this contributes to explaining the decrease in R&D and generally in innovation activities, we organised "hearings" with key company representatives and stakeholder organisations. Six groups of industries were formed, based on their similarities regarding their proximity in the value chain and markets, R&D and innovation conditions. The groups are: 1) Metal, electronics, machinery, textiles 2) Med-tech, bio-tech, plastics 3) IT products, IT services, watches 4) Finance, fin-tech, insurances 5) Food, cosmetics, retail and 6) Energy, clean-tech, construction.

For each hearing, participants were sought who would have an in-depth understanding of the key contextual influences on the industries (coming from technological change, changing market conditions, regulatory frameworks, etc.), R&D and innovation activities, innovation collaborations, and the formation of new firms. Typically, they would be representatives of national or regional/ cantonal industry associations and cluster organizations, higher education institutions, research and technology organizations, intermediary organizations (e.g., knowledge brokers, consultancies), or companies (large, SMEs, start-ups). Potential participants for each hearing were assembled via the contact lists of the project team and selected participants, key informants from the project team's networks, lists of experts from Innosuisse, and Internet searches. From a total of 118 invitees, one-third participated in the hearings and about one-sixth provided written input.

Table: Sample of contacts and hearing participants

Hearing	Invited contacts	Participants	
		In the hearing	Written input
H1: Metal, electronics, machinery, textiles	15	7	3
H2: Med-tech, bio-tech, plastics	17	7	4
H3: IT products, IT services, watches	17	4	4
H4: Finance, fin-tech, insurance	17	7	5
H5: Food, cosmetics, retail	31	8	3
H6: Energy, clean-tech, construction	21	7	2
All hearings	118	40	21

Six hearings each lasting 2 hours took place on 15-16 September at the FH Nordwestschweiz in Olten. The hearings were pre-structured in the sense that, in advance, all participants had received a brief written introduction including six questions (see Appendix). These questions were shown to the participants during the hearing and were discussed one after the other (facilitated by one moderator from the project team). During the hearing, the project team and some additional supporting staff from SERI took notes of the answers and comments.

The notes and written input from each hearing were then summarized (see Appendix 2) and returned to all hearing participants for comments and validation.

It should be noted that because participants were hand-picked, the interviews were not able to describe the frequency of certain phenomena or provide comprehensive overviews of innovation activities by sector. However, they served to explore and understand how different concepts were linked to each other, how dynamics emerged and grew over time, what possible cause-effect relationships could look like and what roles different contextual conditions could play. The advantage of group interviews is the interaction between the interviewers and the interviewees (and among the interviewees themselves) which creates associations and chains of reasoning that can uncover more than bilateral interviews. However, it must be understood that the results are not representative or conclusive in any way, but are only exploratory, permitting first hypotheses and interpretations which then require further analyses with larger datasets, before any robust conclusions or policy implications can be formulated.

4. Results of the hearings

In this section we present a brief summary of the results from each hearing focusing on the changes to innovation models as identified in the respective industries. The appendix provides the full information from the hearings.

4.1. H1 Metal, Electronics, Machinery

There is a trend towards more competition, especially from Asia, greater digitalisation of products and services, and greater complexity due to dealing with different technologies. In addition, the companies often faced significant changes in their cost structure and had supply chain issues, which affected productivity gains and their EBITA. This led to a shift in the innovation paradigm towards increased speed of innovation, a stronger focus on innovation systems rather than a deepening of technology, a change in the skill requirements for employees and a reduced focus on radical innovation. Consequently, the heterogeneity of R&D investment intensity increased among SMEs, and many of them focused more on incremental innovations (in the technological sense). There was also an increased pressure to reduce payback time, a shift from technology-driven to value-driven innovation, and a significantly stronger focus on combining technology with new business-models. In order to remain innovative in such a dynamic environment, some companies collaborated with large players in the software

market, such as Microsoft. The importance of other institutions like Inspire, the universities of applied sciences (UASs), or the ETH Domain has also grown. Managing the risks of an innovation project became more vital, too. This led to smaller, agile projects focusing on incremental improvements, rather than on research-based innovations. Time-to-market became critical, which significantly shortened product life cycles overall. Testing or co-developing new products with customers as quickly as possible also gained in importance. Customers became more integrated into the innovation process. Increasing time pressure also forced some companies to focus more on their core innovation competencies and to try to partner with external institutions and other companies to acquire complementary capabilities.

Given the major changes in the innovation environment and the increasing pressure on the profitability of innovation, there was no consensus on the need for new support instruments, such as direct subsidies. However, there seemed to be an agreement that the existing instruments should be improved and made more visible, especially for the SMEs. The framework conditions should also be further improved.

4.2. H2 Medical technologies and bio-technologies industries.

The hearing on med-tech and bio-tech industries highlighted two main trends and long-term changes which would affect the innovation models in these industries and the importance of R&D in generating innovations in Switzerland: 1) Regulations above all at the European level, but in some cases also on the global or the national one affect and, in the worst case, even disincentivize innovation. Some examples are the new European medical device and in-vitro diagnostic medical device regulations (MDR/IVDR), the Nagoya protocol, the global discussions on TRIPS, and the Swiss national payment system for medical services. 2) Digitalization has created new opportunities for the generation and the use of patient data, the enhancement of products with digital services or the provision of new, data-based health services. In addition, it was stressed that in Switzerland, the complexity of the innovation ecosystem has grown as many new players have entered the industry, above all in the field of digital health. In research and in supporting functions (e.g., intermediaries, incubators, brokers etc.) new players have emerged as well.

These trends affected the innovation activities of smaller and mid-sized companies: 1) IT systems, hardware, software and data have become more important. IT-related and multiple data-related competencies (e.g., clinical data, patient-related data, e-commerce data, or social media data) have become necessary additions to technological competencies for the success of more complex innovation projects. 2) Even though technological innovations of products and processes as well as the corresponding R&D remain important, data-enabled service- and business-model related innovations, which do not need technological R&D, have been added. 3) Time-to-market in innovation projects has increased due to the additional work needed to meet regulatory requirements (e.g., testing and approval of medical devices). This implies that even with a given budget for product innovation fewer innovations can be brought to market, as each innovation takes longer and is more costly. 4) Companies engage more often in R&D collaborations and other innovation-related ones to master the more complex innovation process and to access all the necessary fields of knowledge and competencies. The diversity of desired skills leads to a diversity of partners being sought in industry, start-ups, academia and other service providers both in Switzerland and abroad. Whereas large companies already have processes and networks to deal with these complexities, SMEs are often overwhelmed and struggle to identify the right partners and collaboration formats. In addition, public innovation support measures, e.g., the programs managed by Innosuisse, do not yet permit such complex partnership constructs, and being too bureaucratic, time-consuming, and rigid, they generate additional administrative requirements.

4.3. H3 IT products, IT services, watches

The global landscape has indeed evolved. The consequence is that innovation activities which previously seemed reasonable, appear now to be a waste of time and money. And this even though their

need, nature, and potential impact have remained fundamentally unchanged. R&D can't guarantee return-on-investment and R&D activities are lessening. Resources for innovation are becoming tight and SMEs cannot build or finance innovation departments. Swiss SMEs focus on the design and the implementation of products and services. A merger with or acquisition of a successful start-up or competitor is often viewed as a less risky and a better financially quantified investment than the maintenance of R&D organizations and facilities.

A strong point is the development of start-ups thanks to an efficient ecosystem. This fact has been observed by investors all over the world. Thanks to high investments, product development and access to markets have been successfully supported in areas such as quantum computing, security, AI, etc.

Industry-academia collaborations have become more and more popular, as they represent a less costly alternative to internal R&D in terms of FTEs, computing resources and other expenses. If well targeted and managed, these collaborations can bring significant value to firms. The UAS have a central role to play. Open innovation by large firms is the rule in order to monitor and implement start-up innovations. One important fact to keep in mind is that academia can very well carry out research, prototyping and sanity checks, but it can never offer an alternative to internal product development. Companies often prefer bilateral collaboration rather than big multilateral projects (such as in EU consortia). Being focused is central as time is important for innovation.

The US industry has greatly increased its activity in Switzerland and has undertaken R&D among other things. The location of US tech companies strengthens the formation of clusters and the attractiveness of Switzerland when international talents are considered. Here, both the ETHZ and the EPFL play an eminent role.

Software is at the core of every innovation. Innovation needs to be iterative and more customer-centric. However, many companies have no idea about what customers are doing with their products (e.g., the watch industry was mentioned as an example). Digitalization of products is important, (to get user data) but complex. It is important to let innovations be "experimented" with in the real economy – particularly if they are customer-centric. These are real experiments which need to be supported by adequate regulations and institutions (sandbox). Business model innovations (BMI) become central and are more customer-centric than product or process innovations. However, they require new and different competences than what is required for product or process innovations. Traditional companies struggle with BMI because developing them raises cultural issues. Are we training business model innovators?

Portfolio strategy is important to avoid "putting all the eggs in one basket". Firms can increase the breadth of supported projects while providing limited funding to a larger number of projects. A portfolio strategy requires some capacity for interim evaluation and flexibility.

Switzerland's IT research has a good reputation and is highly attractive. It is good in basic research, patent creation and start-up but less good in growing a company and in implementing the innovations in real products. As a result, the relevance of traditional innovation KPIs as a proxy for innovation strength needs to be challenged.

Innovation needs more computer scientists and engineers. There is a labour market problem: large tech companies are able to attract top talent, but SMEs and even academia are struggling to hire IT experts.

4.4. H4 Finance, fin-tech, Insurance.

The increasing digitalisation of the banking and finance sector, growing competition from fin-techs, regulations, demands for sustainable products/services, and demographic changes are among the key drivers of innovation behaviour and enable new business models with a strong technological component. Specifically, the use of artificial intelligence is accelerating business processes and offers new opportunities for analytics and product development. Disruptive innovations are frequently coming from outside the banks, especially from fin-techs. The traditional architecture of banks is now often perceived as a barrier to more disruptive change. Banks have cut their R&D budgets and the remaining internal

R&D is more closely linked to the companies' core strategies. Moreover, innovation cycles have shortened, and time-to-market has become more important, making it more difficult to pursue longer-term research projects. In general, innovation activities in banks are more closely linked to information technologies. This increases their complexity and, combined with scarcer financial resources, leads to smaller innovation projects. The pressure for more agile " speedboats" (e.g., credit card billing apps) has increased significantly, especially in the front-end of the business. This is where the innovation momentum is greatest. There is also a trend towards greater segmentation of the value chain. Universal banks that cover the entire value chain are increasingly becoming part of a more diversified ecosystem. To remain successful in such a dynamic environment, a change in mentality towards more openness, partnership-based interdisciplinary thinking, collaboration with competitors (coopetition) and an "allowance for failure" is needed.

Attractive framework conditions for innovation are very important and should be a priority for policy makers. This includes a stable infrastructure, fully digitalised communication (no more paperwork; e-government; e-identity) and open, automated interfaces (APIs). This would open up new spaces for software development and innovation. Policymakers should generally promote a culture of innovation, testing and failure ("sandbox" principle). Existing "round tables" are welcome, and more are needed to further develop the regulation of financial markets and to improve the flow of information between stakeholders on projects in the administrative area. A central contact point (one-stop-shop) for innovations should be established. A data hub is needed, bringing together all the relevant and particularly cross sectoral information and issues (e.g., concerning data processing, DLT/blockchain, artificial intelligence) and giving banks/fin-techs access to develop better/innovative products. Policy measures should specifically address the skills issue in Switzerland, for example, by making the country more attractive to international talents. Innovation means taking risks and often requires collaboration with other companies/institutions. Therefore, a functioning ecosystem is necessary.

4.5. H5 Food

The participants of hearing 5 on food and retail industries placed a strong focus on the former. Two contextual factors shape innovation activities in the food sector: 1) First and foremost, rapidly changing consumer preferences and new consumption trends follow topics such as nutritional value, vegan/plant-based food, sustainable food (carbon footprint, waste etc.) as well as more and faster food innovations. 2) New technological possibilities (e.g., wet extrusion, precision fermentation, cultured food, health ingredients) permit new products and production processes. Demanding regulations for quality, food safety or ingredients, changing export conditions (appreciation of the Swiss franc) and replacing retailers' product and procurement policies also strongly influence where and how Swiss food companies can innovate.

In the case of food companies, the following changes of innovation models were referred to: 1) Incremental innovations, i.e., efforts to adapt products, recipes, ingredients, etc., have increased compared to radical innovations, i.e., the development and introduction of completely new processes and products. Shorter shelf-lives of new products (due to changing customer preferences, retailers' product policies, frequent and fast recipe adaptations) and cost pressures have reduced the attractiveness of long-term investments in fundamental innovations. 2) Innovation activities must deal with more diverse and complex knowledge fields (production technologies, consumer preferences, legal requirements) and with more pressure to generate returns to R&D. The main solution to this problem has been more open innovation: consumers, retailers, academic (higher education and research) organisations, new scientific service providers, start-ups, suppliers or other partners in the value chain are being sought to become collaborators. 3) Academic institutions are difficult partners for SMEs (even more so than for large companies) because of several characteristics and differences: e.g., different cultures and time horizons, few short term collaboration resources , universities' intellectual property rights (IPR) regulations (except for universities of applied sciences), the focus on scientific goals and lack of interest in incremental improvements, disciplinary structures that struggle to respond to interdisciplinary practical problems. 4) Start-ups were highlighted as an important place for university-invented innovations which then

can be marketed in cooperation with Swiss-based large multinationals. Even though funding conditions for food-tech and agro-tech seem to have improved, Swiss food start-ups still seem to struggle to find access to competences, infrastructure, IP rights, and regulatory authorities.

4.6. H6 Energy and clean technology

The general picture is that fewer companies are doing R&D inhouse. Keeping the financial crisis from 2007-09 in mind, SMEs emphasize optimization (process & product). External knowledge is, therefore, more important now than ever before. There is also more external knowledge to acquire. The VC-start up model works well – although the scaling phase is still underfunded and not all energy start-ups can match the VC model of funding. Larger companies are investing more in start-ups – making the start-up ecosystem more complete. Finally, the internationalization of the value chain is increasing the global dispersion of suppliers creating issues in project management.

SMEs are developing a culture of collaboration both with the public research system and with other companies. The idea that innovation comes from academia is still strong, but SMEs have increased their collaboration activities with other companies. This directly impacts the way new products/services are designed. It is easier to collaborate with the UAS or the CSEM than with the ETH schools. Understanding behavioural and social practices is becoming key for innovating firms to make their business models evolve. In these areas, closer collaboration with universities and the UAS has to be fostered.

Speed is becoming a key characteristic of any innovation project. Innovation is also more customer-centric. Most innovations are incremental. SMEs are trying to maintain a project portfolio which corresponds to the network of the company and also co-evolves with it. Projects are more complex, requiring diversified competences which implies efficient networks and partnerships.

As a consequence of the energy market liberalization, business model innovations are emerging as an important form. Sustainability requirements have increased massively. It is becoming a real business model not just a marketing innovation. IT and digital technologies are creating huge opportunities for process as well as product/service innovations. Organizational innovations are increasing.

The impact of Covid and the Ukraine war have affected different activities and stages: the supply of resources (including human), the cost uncertainties due to price volatility, logistics and unstable and fast-changing cross-border restrictions. All these factors have shifted the focus towards local supply chains and local resources.

On the policy side, there is a need for more instruments to engage SMEs/industries in artificial intelligence (AI). Direct subsidies to firms should be made possible in Switzerland – Swiss SMEs are now competitively disadvantaged vis a vis other countries. Financing instruments within the value chain to industrialization are missing (or current instruments have eligibility criteria which are too restrictive). Innovation policy can have no effect unless a strong environment policy is in place (to get all prices right so that clean tech and clean energy are not disadvantaged when compared to dirty energy). It is also important to be able to keep the best people (PHDs, postdocs, talents) and to attract talent from abroad.

5. Salient overarching features

This section takes a cross-industry perspective as well as describes the main contextual dynamics and changes and explains how they have affected Swiss corporate innovation activities, as described by the hearing participants in their oral and written inputs. The key contextual dynamics are fourfold: 1) Customer centrality has increased (for instance, to distinguish oneself from omnipresent global competitors); 2) Some Swiss industries are affected by the global competition even more than before, particularly by Asian competitors, whose technological capabilities have grown in the past two decades. Further competition with disruptive potential comes from new entrants to the affected sectors. 3) Digi-

talisation has become ubiquitous regarding products and services, but also regarding almost all processes which companies have to master to be successful; 4) Regulation has become more important in certain sectors, and Switzerland's attitude and approach to regulatory change is not considered to be proactive enough. These dynamics have incentivized and triggered certain reactions in corporate innovation activities, one of which is the decrease of R&D and increase of the commonness of incremental innovations that can be seen in innovation surveys (see background section above). Further changes in the companies' innovation activities are described in section 5.2. below.

5.1. Key dynamics and changes affecting Swiss corporate innovation activities

Customer centricity. A first important and new dynamic, regarding its power to disrupt current business practices, is the growing importance, or rather the "empowerment" of consumers. This was mentioned in several hearings. It is driven by the internet and social media which support widespread information retrieval and the exchange of anything that deals with corporate product and service provision. Customers can quickly and easily gain an overview of prices, quality, or sustainability and purchase goods electronically from far away locations. This matters not only in consumer markets (e.g., watches), but also in service industries, such as the health service industry, where patients look for and evaluate information based on the value of treatments before accepting their price. The banking industry can serve as another illustration, where private customers expect the same level and low cost of digital banking services that they experience in the retail sector. Customer centrality mirrors the several dimensions of what makes a new product or service successful: a) products should not be "good enough" to match a large market, but be aligned to specific (individual) needs, tastes, and practices; b) products should not remain unchanged over time but be continuously adapted to changing behaviour, tastes, etc. c) There are several implications for innovation: business model innovations (BMI) flourish based on differentiated demands, big data and the digitization of products. In addition, services to "understand" the consumers' evolving practices become central, and lastly, flexible and agile advanced manufacturing tools need to be designed to support the product changes.

Global competition has increased, and this affects any innovation activities on the home market and particularly on the international ones (strongly in MEM, but also in food and Med-tech. In some sectors, it is becoming increasingly difficult for Swiss companies to distinguish themselves through their superior technologies due to the increasing technological capabilities of companies abroad, above all in Asia. This is not the only source of competition, though. New players from other industries are also entering the markets with superior capabilities in new and expanding areas. This trend has gone beyond Amazon and retail or cloud services. It also affects banks, health or energy companies which are competing with Google, Amazon, Meta, Microsoft, or Apple (GAMMA), with other larger IT and technology companies or with start-ups with little industry experience and knowledge, but with strong IT competencies.

Related to this, *digitalisation* is the second dynamic which can hardly be described as new, but which still has not been fully understood and integrated into corporate practices. It obviously creates opportunities for new digital products (e.g., digital health services, digital banking). It is also the source of new data, for example, from patients, consumers, digital sales channels, or digital communication (via social media) which facilitate new digital products and services or new digital/digitally enhanced business models. Artificial intelligence (AI) and machine learning (ML) were mentioned specifically in the hearings, as technologies which have enabled new product opportunities, but also process changes. In connection with digitalisation, a new or changed skills set was also referred to as being missed. Digital skills in hard- and software are needed as well as data access, storage, processing, and analysis. However, the Swiss education system neither provides sufficient digitally qualified graduates nor is it easy (above all for SMEs) to access these skills by collaborating with academic institutions or private service providers. Hence, many companies seem to be behind because they don't have either the required speed or level of digital change of their activities.

Regulations have taken on greater importance, at least in the sectors where certain sensitivities exist, for example, those regulating environmental impact (e.g., in the energy sector) or social consequences,

health effects and product safety (e.g., in the health and medical technology sector) or systemic risks due to the interconnectedness and cross-cutting function vis-à-vis the overall economy (e.g., in the financial or IT sector). New regulations dealing with product approval/certification, intellectual property, or market access have broad implications for all product development processes and timing, production processes or even corporate location choices. New regulations are, above all, perceived as challenging during an introductory transition phase because they create uncertainty. Later regulations, of course, can provide stability (for innovation activities as well), because they define the rules and reduce the risks at corporate/project levels. The hearing participants have the impression that Switzerland's position outside the EU adds another layer of uncertainty in addition to additional time delays when regulations should be adopted. Switzerland has been described as rather slow in reacting to new regulations (e.g., in the health sector), developing its own regulations (e.g., relevant for banking, fin-tech), or deregulating (e.g., in the energy sector) which weakens the position of Swiss companies compared to their foreign competitors.

One additional point worth mentioning is *sustainability* which was mentioned several times, for example, in connection with new environmental regulations, or the increased customer awareness of food, energy, or finance ("responsible saving"). However, at least in the hearings, sustainability was unexpectedly less often the main topic of the discussions and it was less often singled out as a driving contextual dynamic than the other four dynamics described above.

5.2. Key changes of Swiss innovation activities

Swiss companies have adjusted their innovation activities because of these dynamics. Some of the reactions were already discussed in the background section above: fewer companies conduct R&D, R&D intensities have increased in companies that still conduct R&D, the importance of extramural R&D activities and R&D contracts has also grown. However, radical innovations are less frequent than before. The hearings echo these survey-based statements and trends and provide further details about innovations (both from an output and a process perspective) across the entire Swiss economy and for particular industries:

- *Increasing complexity of technologies and innovations.* Innovation processes and the resulting innovations have become more complex than in the past, considering their content (e.g., the integration of hardware, software, and data), as well as the knowledge and skills needed (e.g., greater variety of disciplines are needed to be successful). This is also reflected in the insight that innovation projects more and more target entire product systems (hardware, software, data, services) and not just the core underlying technologies. The combination of traditional technologies with new digital technologies (e.g., artificial Intelligence and machine learning) has become an integral part of innovation in different industries. Companies need to deal with these multiple complexities, and a standard reaction is open innovation and more collaboration, above all, when it is not possible to improve internal skills and knowledge efficiently and effectively.
- *Value-centric innovations.* In several industries, customers are being integrated more and more into the innovation process. The broader systemic scope requires value-centricity and quicker feedback from customers and users, leading to more agility, faster product designs, more rapid testing (e.g., minimum viable products MVP). As the scope of systemic innovation grows and as technological sophistication cannot easily be increased or if the pay-off is small (compared to the high efforts and costs to generate it), then more innovation projects have only an incremental scope and consist of mere adaptations. Smaller, agile projects focus on these incremental improvements instead of on research-based, fundamental innovations. Shorter product life cycles and shorter payback times also work against more radical and long-term innovations. They induce companies to integrate the standard solutions from the big software companies into their innovations.
- *Business model innovations (BMI)* have become more important, reflecting a shift from technology-driven to value-driven innovation. There is also a stronger focus on combining technology with new business-models. BMI can relate to more digital services (e.g., health, MEM, energy), by giving technology/IT a more prominent position in the business (e.g., banking, food), and by reaching out

to/involving customers (e.g., IT). However, the hearings participants believe that a common and shared understanding of BMI seems to be still lacking. Even though few would reject its importance, it may still mean very different things to different firms and industries which makes it a challenging concept for scientific analyses and political measures.

- *Changing time horizons for innovation projects.* Another striking similarity from all the different hearings was the mentioning of shorter time-horizons of innovation projects (e.g., food, MEM, finance) due to rapidly changing customer preferences, competitive pressure, as well as shorter product life cycles and payback periods. This pressures companies to speed up their innovation process. It also works against starting more fundamental innovation projects instead of only making short-term and incremental adjustments. It forces companies to focus more on their core innovation competencies (and fill in the gaps by partnering with external institutions and other companies to acquire complementary capabilities, see below). The pressure for more agile "speedboats" (e.g., in banking, credit card billing apps) has significantly increased, especially in the front-end of a business. Two exceptions from this general trend appeared: in the hearings with representatives from the med-tech industries and from the energy and clean-tech industries. They mentioned the opposite trend, namely a reduction of speed and longer innovation time-horizons, driven, for example, by new regulations and higher product complexity. This could actually become a strong reason for concern if this lengthening of innovation cycles applied only to the Swiss med-tech and energy companies. This fact could weaken their position if the competition went in the other direction.

All these points or characteristics of innovation projects and the resulting innovations work together in the same direction: they demand a wider set of activities for the successful creation of innovations, and they fragment the contribution of the individual companies and other actors in the value chain. Fewer companies seem able to master entire innovation processes. For some companies, these points also reduce the importance of research and technological (hardware) development, but for others it even more important. Hence, the heterogeneity of R&D intensities among SMEs has increased, as we can see from the concentration of R&D in the Swiss innovation survey data (see background section above).

This, indeed, goes hand in hand with another salient overarching insight obtained during the hearings: *collaborations and the openness of innovation projects* have increased. To remain successful in such a dynamic environment, more openness, partnership-based interdisciplinary thinking, collaboration with competitors (“coopetition”) and an "allowance for failure" is needed. “Collaboration” is a generic construct covering many different forms, configurations, and time horizons. Three frequent collaboration types were mentioned by the hearing participants: 1) Short-term bilateral collaboration to resolve specific problems in incremental innovation projects 2) Long-term and stable partnerships, in which academic organisations take over the role of external R&D departments 3) Multilateral projects and consortia that work on (the foundations of) systemic innovations which have many different components, complements and the linkages between them. All these things need to be changed for innovation success (e.g., in digital health, blockchain, AI, etc.). Above all, multilateral projects and consortia can handle the increased complexity of knowledge and skills needed. They can also resolve the problem of skills shortages and the incapability to hire employees who have the high demand skills. Collaboration was also described as a mechanism that can enable a reduction of internal R&D investments and innovation development risks. When such collaborations result in more than just a mere purchase of an innovation service, costs can be shared and the risks of innovation lessened from the individual firm’s perspective, even though, at an aggregate level, the costs and risks might not even change. Although SMEs are more in need of collaborations because they have fewer internal resources, they are also the company type that struggles most with implementing change. Large firms are better equipped to handle collaborations than the SMEs because of their higher absorptive capacities. They have more resources to scout for partners/technologies and to collaborate. Their networks are larger and more visible, their processes and routines more established. In many cases, their locations in EU countries give them better access to European research organizations and they are eligible to participate in the European R&D framework programmes.

Not only has the scale and scope of collaborations grown, but the *consortia and partnerships in R&D and innovation have also become more diverse*. This is because the broad set of skills and resources that is sought can only be found in different types of organisations (academic, start-up, large IT companies, scientific service providers, etc.) and people (customers, patients, etc.). Above all, collaboration not only with larger software companies (GAMMA) but also with other institutions like Inspire, the UASs, or the ETH Domain have become more common. Still, it was mentioned several times that it is difficult to partner with Swiss academic organisations due to different work cultures and interests in comparison to companies (regarding basic/applied research, publication, practical work). In addition, their varying sizes, and disciplinary structures as well as the IP policies of some organisations are important. In this context, UASs have gained in importance as partners due to their more industry-oriented culture and interests. A further need for more collaboration (e.g., in the form of roundtables) between industry players and Swiss regulatory authorities was recognized in order to avoid new regulations from blocking innovations. Regulation processes should also be sped up.

5.3. Comments on innovation policies

The hearing participants offered their opinions and assessments of Swiss innovation policies as well. As can be expected, some comments related to issues that have already been debated among Swiss research and innovation policy makers, whereas other comments are relatively new. The following list summarises the main overarching points:

1. There was no consensus on the need for new support instruments, such as *direct subsidies to companies* for innovation activities, e.g., within Innosuisse projects.[7] This idea was rejected mainly due to the assumption that Switzerland's overall budget for innovation promotion cannot be increased in the short term and that the direct promotion of companies would be at the expense of economically more effective research and innovation promotion for universities and research organisations. In contrast, it was pointed out that public co-funding reduces the private risks of innovation projects, and subsidies to firms would help them avoid the bottlenecks found in public research organizations. Researchers in high demand, e.g., at the ETHZ or the EPFL, are overloaded with requests for collaboration and “booked out” for long periods of time. Last but not least, the direct subsidies of innovation companies’ innovation activities could also replace the currently missed EU R&D and innovation funding (above all for SMEs and start-ups outside of EU member states).
2. More *agility, flexibility, and speed of innovation promotion measures and less administrative and documentation work* have been called for several times, especially during project conception and application phase. In essence, this amounts to a mismatch between the way innovation support is organised and the way companies approach and implement innovation projects today. Innovation promotion contrasts strongly with the mindset of the entrepreneur. In particular, the following things were mentioned: greater flexibility in terms of content and partners, smaller "stages" with shorter work cycles and more frequent testing, customer involvement, trial-and-error, and in consequence and if it makes sense, fresh starts with different objectives and orientations. Swiss innovation support measures still function according to the academic knowledge transfer/exchange paradigm or sometimes even stress it further (e.g., Bridge)[8]. However, corporate innovation practice has become more agile with regard to partnership configurations in innovation projects, project organization, and innovation processes. Companies tend to move development (and most likely also research) to countries which better accommodate such needs.

[7] The new Innosuisse instruments for direct funding, the Swiss Accelerator funding scheme, which supports projects by SMEs and start-ups once they have entered the market (https://www.innosuisse.ch/inno/en/home/promotion-of-national-projects/swiss-accelerator.html) and the Start-up innovation projects for science-based projects of start-ups with significant innovation potential (https://www.innosuisse.ch/inno/en/home/promotion-of-national-projects/startup-innovationprojects.html) were not yet considered by the hearing participants.

[8] Bridge is a joint offer of SNSF and Innosuisse with two funding opportunities at the intersection of basic research and science-based innovation (https://www.innosuisse.ch/inno/en/home/promotion-of-national-projects/bridge.html): Bridge Proof of Concept funds mainly young researchers with applying and developing further research results into marketable offers. Bridge Discovery supports experienced researchers with generating innovations out of research results.

3. The risk of companies moving to foreign locations increases if a long-standing strength of the Swiss innovation system cannot be overcome, namely the *lack of qualified employees.* This is now a bottleneck at least in some sectors and professions. The creation of appropriate curricula at all levels and the strengthening of "computational thinking" and programming skills have been deemed necessary. It has been questioned why qualified graduates from the leading universities had to leave Switzerland after finishing their educational careers just because they had the wrong third country passports. Above all, SMEs and companies in peripheral and rural regions would suffer from the scarcity of skilled IT engineers and STEM graduates.
4. In all hearings, *start-up policies* surfaced in one way or another. Comments ranged from a general praise of the Swiss start-up ecosystem to a fundamental critique and observation that it is a "closed, self-funding tool for experts and coaches with endless events, kick-starters, prize winners, etc." (written input by one of the hearing participants). However, more support would be generally welcomed above all regarding the access to infrastructure (specialized and pilot laboratories, workbenches, etc.) and, of course, funding. Funding for the early stage and the scaling of start-ups is perceived to be particularly scarce. The question of a federal start-up funding mechanism was also raised several times and most of the hearing participants were in favour of it. Such arguments centre around the fact that VC and business angel funding, while desirable and a possible signal of quality and confidence in the economic potential of a start-up, tend to follow a specific logic of rapid scaling, high growth, and a short time to exit. Besides a few industries, this fact fundamentally disadvantages start-ups from acquiring funding and, in the worst case, deprives them of any funding opportunity. How such funding gaps can be closed has not yet been convincingly answered in Switzerland.
5. Another aspect was mentioned under the headline of *sustainability.* It could provide directionality to innovation policies and support dynamics that are desirable from a societal perspective. Whereas renewable energy has been supported for several years, such support is virtually non-existent for sustainable food, sustainable finance, etc. However, a smart policy could contribute to functioning innovation ecosystems in many ways. For example, the following were seen as possibly interesting approaches: the inclusion of sustainability indicators or the UN's Sustainable Development Goals in innovation policies. Next, the convening of roundtables to discuss the regulatory aspects of sustainability transitions and their consequences for innovation policies. Many companies, above all SMEs, still struggle with understanding the consequences of sustainability for their products and business models. These SMEs would benefit from targeted initiatives (e.g., at industry level) and support to help them prepare for possible new (European) regulations on sustainable products and product traceability.
6. Moreover, improving the *contribution of the public sector to innovation* was mentioned several times, a subsequence of the debates on the role of regulations (see above). One discussion referred to stable (IT) infrastructures, fully digitalised communication (no more paperwork, all communication could be done via e-government; full use of e-identity) and open, automated interfaces (APIs) which would reduce a company's administrative burden and free up resources for other activities, e.g., innovation. A second discussion centred around a deepening of the collaboration between industry and regulatory authorities to speed up and support the creation and adoption of new regulations and standards. A third strand stressed health care, finance, and energy. The creation of data hubs needs public authorities in all aspects, e.g., developing rules and settings to make patient data available for health innovation, or generating data hubs for finance and fin-tech. The Swiss Federal Statistical Office was mentioned as a possible both knowledgeable and trustworthy organisation that could extend its task portfolio and provide expertise for such developments.

It is important to make clear that the above-mentioned measures are neither the authors' suggestions and interpretations, nor are they recommendations resulting from profound analyses of Swiss innovation systems or policies. They are perceptions from industry experts resulting from their day-to-day involvement in innovation activities. Different perspectives (from managers, engineers, scientists, representatives of industry associations, consultants, or other industry experts) were combined and presented here without trying to remove eventual contradictions or expecting that each and every expert would agree with all the points made.

6. Conclusions and outlook

If there was a dominant theme from the Olten hearings, it was the *growth of the complexity of innovation*. This comment was frequently repeated, and it can be generalised for all the sectors considered. This increasing complexity has certain causes as well as some consequences regarding the way in which companies – and particularly small and medium-sized companies – manage innovation.

The complexity of innovation: an emerging property from a cluster of "new" trends

The different hearings highlighted several trends that can be found in all the sectors considered and that contribute to the increased complexity of innovation activity.

The first trend is the one that results in the centricity of the consumer and, more widely, the client in processes of innovation. This centricity reveals itself in different phenomena: the individualisation and extreme differentiation of the needs and wishes of the consumers and clients; the permanent evolution of these needs and the continuous transformation of products and services; the growth of consumer skills and the power of the tools that allow them to constantly analyse the market, to compare competing offers and select the ones that meet their needs best and to generate the highest value; and finally, their capacity to make contributions to innovation projects that concern them.

The second trend complements the first one. It focuses on the digitalisation of innovative products and services which provides consumers and clients with new functionalities. In addition, it offers companies the tools that enable them to observe and understand the behaviours of users based on the continuous analysis of the uninterrupted flows of data produced by digital devices. This big data as well as the machine learning approach to innovation and design will create a better fit for customers whose characteristics can be discovered. While some products and services can be offered completely digitally, in most industries, innovative products and services will involve a mix of digital and physical components in their final products, with the digital ones often becoming progressively more important.

The third trend concerns the marked demands for sustainability to be included in most product and service innovation projects. These demands will include not only standards and norms aiming to limit pollution or emissions but also questions relating to the life cycle of products, the recyclability of material goods, waste management, the banning of certain non-renewable materials, a modular design favouring the repair or the replacement of defective parts. In most sectors, the transitioning towards a sustainable, circular and "sharing" economy will create a new stress field as well as opportunities for innovation and new business models.

The fourth trend is the growing influence of regulations. This trend is typical in most domains and implies that the feasibility of an innovation project is no longer only a technological and economic question but also a regulatory one. This influence is ambivalent. On the one hand, the prospect of future regulation creates uncertainty and induces costs which can discourage innovation. Innovation managers then need to consider and assess the likelihood that a regulatory agency or a court decision could destroy any expected benefits through regulatory requirements or a judicial rule. On the other hand, a new regulation can enable innovation activities if, for example, data could be more easily accessed, or the direction of innovation could be influenced such as in the case of regulation dealing with emission standards and other sustainability norms.

Finally, the last trend that again characterises numerous sectors is the transformation of the competitive environment – particularly with the eruption of Asian competition actively performing on market segments that, until recently, remained a sort of "exclusive domain" for companies of certain European countries (including Switzerland). Other potential "aggressions" to existing industries are caused by the disruptive actions of new firms as well as by big technological firms, especially the American ones.

These trends – at least some of them – are also interdependent as they mutually reinforce each other. That increasing competition will shorten product-life cycles is one example. Reducing time-to-market

becomes more important which in turn forces companies to introduce more incremental innovations rather than more radical ones.

Implications of the increasing complexity of innovation: five "new" practices

This increasing complexity of innovation has very important, obvious consequences for the way in which small and medium-sized companies will produce innovation. These companies will endeavour to respond to this complexity by developing new organisational practices and opting for certain forms and logics of innovation. Based on the *hearing*s, five practices can be emphasized:

The first practice focuses on the necessary mobilisation of *new types of competence and qualification*, particularly in the domain of data science and consumer behaviour analysis. Companies need to understand how to combine various information sources to obtain a high-resolution image of their consumers' revealed preferences. Up to now, this has remained private (e.g., their incomes and purchasing patterns). The result is that the wealth of information on consumer behaviour is changing corporate innovation strategy. New competences in the domain of sustainability engineering and circular economy are also a required part of the framework of many new innovation projects.

The second practice focuses on the adoption of a *renewed vision* of innovation. This vision goes beyond the purely technological achievement or supply of a new service. It focuses on the invention of new models to generate value for customers, to reach out to customers and to secure business returns. There is a move away from a product innovation towards a business model innovation. This must incorporate many dimensions of technologies, services, the collection and the processing of data as well as regulation compliance. The success of these innovations is, moreover, very dependent on the company's capacities for digitalisation and sustainability.

A third practice adopted in response to the increased complexity of innovation is *focalisation*. Firms are concentrating their innovative efforts on parts or components of larger technological systems which they can no longer entirely master. This focus provokes a vertical disintegration of the value chain, a fragmentation of innovation and its reorganisation in the form of a contract network (which in return can further increase the complexity). It greatly complements the collaboration practices (see below).

The preference for *a step-by-step process* of innovation represents a fourth practice. This permits rapid market testing, feedback from customers and partners as well as continuous readjustments in order to cope better with the complexity. This logic of "gradualism" currently dominates the more radical approaches to avoid excessive resource waste on projects with a high probability of failure within the context of increasing complexity.

And finally, an explosion of *collaboration practices* can be observed not only within public research institutions but also within other companies – whether these be suppliers, clients, R&D and engineering business services, or even competitors.

A last point is a reminder of what could be called a meta-practice (or *dynamic capability* in the sense of Teece, et al. 1997; Eisenhardt & Martin, 2000). This corresponds to the fact that most of the practices identified are actually complementary. It is important that they be adopted together. Therefore, the companies should set up systems of complementary practices since each of them will have a greater effect in the presence of the others. This is especially the case when the four practices are linked with new competences, new innovation models, focalisation and collaborations.

The new issues of innovation policy

We have underscored this new phenomenon concerning the increasing complexity of innovation, which is pushing companies to adopt new innovation practices. Some of them are virtuous in terms of productivity gains and social impact. They entail new competences regarding digitalisation and sustainability, the development of business model innovations incorporating digital technologies and sustainability

objectives, and the multiplication of collaborations. Others are at best neutral from this point of view (incrementalism, concentration).

The phenomena identified during the hearings and described in this report are not limited to Swiss industry. They also appear in other industrialised countries as well, of course with some degree of variation according to the national research and innovation systems, industry structures, positions in global value chains and other contextual influences. Innovation policies have begun to show a reaction, partially with considerable new investments, as the following examples show:

- Finland is a European country that is generally perceived as an innovation leader (European Innovation Scoreboard 2022). It has a rising share of R&D-active companies, but a stagnation of overall R&D expenditures (Wörter & Spescha, 2020). It already adopted its "National Roadmap for Research, Development and Innovation" in 2020. The country clearly has the objective to increase overall R&D investment from 2.7% to 4% of GDP in 2030 and to activate SMEs: *"Finland needs more companies engaged in RDI activities. The research, development and innovation of companies in the SME sector must also be activated. A share of turnover larger than at present must be invested in RDI activities.»* (Finnish Government, p. 1). Three strategic development areas, a new partnership model, and an innovative public sector have been highlighted as the critical targets of a set of new policy measures.
- The German Federal Government very recently communicated its "Zukunftsstrategie Forschung und Innovation" (Future Strategy for Research and Innovation), which will replace the previous High-Tech Strategy 2025. It will develop its research and innovation policy further to protect the natural foundations of life, secure Germany's international competitiveness, strengthen the resilience of German society and ensure the country's economic strength. It also includes the creation of a German Agency for Transfer and Innovation (Deutsche Agentur für Transfer und Innovation, DATI) to promote innovation communities and strengthen regional innovation ecosystems, address funding gaps, promote application-oriented research, use and expand specific regional strengths (smart specialisation), and finally, identify and involve new topics and actors for specific fields of innovation etc. (https://www.bmbf.de/bmbf/de/forschung/dati/deutsche-agentur-fuer-transfer-und-innovation_node.html). This new agency works parallel to the Agency for Leap Innovations (Agentur für Sprunginnovationen SPRIND), which was founded in 2019 to better enable radical and disruptive innovations in Germany.
- In the US, innovation experts are discussing the design and implementation of a new National Technology Strategy supported by an agency similar to the Defense Advanced Research Projects Agency (DARPA). This initiative should involve the development of critical infrastructures – smart high-speed transit systems, dynamic electric grids with renewable energy sources and broadband internet access. This will, in turn, stimulate innovations in markets that are important for society such as mobility, health, energy access and communications. The ultimate goal is to "*realize research opportunities, fund strategic initiatives independently, and work across, coordinate with, and catalyze initiatives by the existing mission-driven departments and agencies*" (Fuchs, 2021).

These examples clearly show that Switzerland is well advised to analyse in detail recent developments, define goals for innovation policy and develop measures that address the bottlenecks of the R&I system as well as use its strengths to continue the innovation success story of the past.

The next stage of this project will focus on a systematic and sector-specific analysis of the obstacles, difficulties, and opportunities that potential innovators meet in three dimensions which correspond to the triple challenges of digitalisation, sustainability, and collaboration with which innovative companies must deal. These three dimensions are:

1. Data-related practices and needs: The digitalisation of goods and services as well as the increase of all forms of digital communication are central sources for the growth of data and the associated opportunities for innovation. Data on customer preferences and demands helps companies to better understand customer value expectations and to design innovations focusing on customers' real needs. Ac-

cess to data can help reduce the complexity of innovation projects and meet the requirements of regulatory authorities, for example, when it comes to proving the effectiveness of a new diagnostic or treatment device[9]. Access to data on customers, users, and others, not only in the health sector, but in all sectors is a particular problem for SMEs. They frequently miss the internal skills and resources to work professionally with data. Regulatory requirements for data access are strong (e.g., due to data security and privacy protection) while data storage and access solutions might take at the same time public infrastructure character. These are all arguments for the high (innovation) policy relevance of this topic.

We therefore suggest conducting an analysis that examines in detail the current data-related practices and needs in corporate innovation activities.

2. Sustainability-related innovation activities: According to the hearings conducted for this report, sustainability-related innovations seem to be "below the radar" or at least, less prominently discussed than other innovation purposes in some sectors. However, sustainability now has the center stage in innovation-related discussions and is a part of initiatives in many countries (see above). Switzerland cannot fall behind with respect to sustainability innovation. The motto of the new Innosuisse flagship initiative "Disruptive solutions for the transition towards a net zero world" is certainly timely and addresses a pressing need. However, there is still a striking knowledge gap about sustainability-related or ecological innovations in Switzerland not only in the innovation surveys but also in the communication from the Swiss Federal government. The market failures affecting sustainability innovations, e.g., due to negative external environmental effects of production, imply that public policy measures and incentives to trigger such innovations are necessary. The integration of sustainability objectives and criteria in innovation projects is also causing internal (competences, costs) and external problems. A sustainable and circular economy is, by its nature, systemic: any sustainable innovative service or product will make sense only if other, complementary models are already in place. There are coordination issues when the success of one project depends on the success of another. An innovation policy could, for example, put more emphasis on the directionality of innovation to counterbalance market and coordination failures which impede sustainable innovations.

An analysis of current sustainability-related innovation activities in Swiss companies and drivers as well as bottlenecks of such innovations would lay the ground for the discussion of policy goals and the necessity of implementing policy measures.

3. Collaboration practices and needs: Collaboration has become more important, as we learned in the hearings, but it is still not well understood. What characterizes successful collaborations and what determines collaboration success? Collaboration can help overcome skill shortages and deal with problems of complexity, lack of interdisciplinary knowledge, and skill needs. The setting-up of efficient and long-term partnerships with existing institutions and the capacity to create temporary networks to resolve specific innovation problems are essential conditions for the management of the complexity of innovation. These things must be perfectly mastered by companies. Above all, academia-industry collaborations can result in the extension of the boundaries of knowledge and technology which can lead to the creation of innovations with a highly disruptive content . They would then constitute one of the main pillars of Swiss innovation promotion and Innosuisse innovation funding. Innovation cooperation can be somewhat directly influenced by research and innovation policy through the provision of incentives (funding) and the design of regulations (e.g., competition laws, intellectual property laws). In recent years, Innosuisse has been quite proactive in adding new instruments to its collaborative innovation funding toolbox[10]. However, innovation collaborations remain poorly understood. The study of innovation collaborations in Switzerland needs to relate to existing work, for example, the Swiss innovation

[9] Interoperable digital health records are a precondition for using artificial intelligence (AI) for medical services and providing personalised healthcare – the Swiss Personalized Health Network (SPHN, https://sphn.ch/) was therefore founded to build an infrastructure that enables the nationwide use and exchange of health data for research. However, it is currently limited to researchers at the five Swiss university hospitals and the Universities of Basel, Bern, Zurich and the ETH Zurich and does not provide data access to corporate researchers.

[10] E.g., the NTN Innovation Boosters, the impulse programme Swiss Innovation Power during the Covid-19 pandemic, or most recently the Flagship Initiative.

surveys. It should also address issues which are not yet well researched. It remains to evaluate “what really works“, to identify efficient organisational designs and to create more of “what really works“.

Conducting an analysis of the preconditions for successful innovation collaboration, the benefits generated by different partner constellations, and the development of innovation collaborations in economic crises versus high growth periods will help to raise the effectiveness of public collaboration support policies.

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In this report, we have documented the important changes of the contexts, conditions, and practices of innovation. The increasing complexity of innovation raises problems and issues which have been documented here – based on the hearings of Olten. These problems and issues are not going to be solved by just a well-functioning triptych: “start-ups – large companies – universities” which forms an ecosystem attracting the most media attention and policy interventions. It is rather clear that the trends and new contexts documented in this report will have a profound impact on SMEs and the way they design and manage their innovation projects. SMEs were very much present at the hearings. These firms are adopting new innovation practices in a massive way, and this is the category of firms which probably needs the most innovation policy adjustments or new developments.

This policy discussion to create better and more adjusted conditions for SMEs so that they can meet their innovation challenges needs to happen soon. However, we are fully aware that this report just provides some warnings – based on expert’s opinions – and identifies hot topics which should warrant further systematic empirical research to provide a sound base of evidence. This is an imperative if we want to achieve a transparent and robust process of policy discussion.

Such systematic empirical research on the topics mentioned above should be the next step of this project – the ultimate objective being to assess the pertinence of the existing policy instruments and/or of the setting-up of new instruments to help companies reduce the obstacles to achieve the associated opportunities highlighted in this report.

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APPENDIX

Appendix 1. Invitation to hearings and preparatory questions

Exploring new and changing models of innovation in the Swiss economy – an initiative by SERI

Background

The Swiss economy is widely perceived as a success story with regard to science-based and technological innovations and this success is reflected in top positions in several innovation rankings. Swiss innovation policy aims to help continue this success story, primarily by ensuring stable framework conditions for research and innovation, funding excellent research and education institutions and financing competitive research and development (R&D) projects through the funding bodies SNSF and Innosuisse.

However, technological, social and economic developments are changing the conditions for innovation, not only in Swiss companies but worldwide. Important drivers of change are, for example, digitalization and the penetration of virtually all sectors and areas of life with new digital products and processes; the pressure on changing industrial production and consumption due to their ecological consequences and the depletion of natural resources; political and health crises and their consequences for supply chains or sales; last but not least local economic dynamics, such as the appreciation of the Swiss Franc since the financial crisis 2007-09 or the non-association to EU Horizon Europe R&D funding.

These recent dynamics impact the models of innovation in Swiss companies in part fundamentally, as we can see from innovation and R&D data: the share of Swiss companies conducting R&D has approximately halved over the past 20 years (about 13% of companies conducted R&D in 2014-16, according to the 2018 Swiss Innovation Survey). In the same time period, the (fewer) companies engaging in R&D have actually spent a higher share of their turnover on R&D and they have engaged more often in R&D collaborations. Still, over the years fewer firms have introduced technological innovations.

Goal and approach

The data paint a complex picture, but it is clear that changes in the economic environment of companies have also led to changes in the innovation models of SMEs in particular. Such changes need to be studied in detail so that innovation policy can respond to them. The current initiative of SERI therefore aims to explore the new and changing forms of innovation in Swiss companies, with a special focus on SMEs, to guarantee the effectiveness and efficiency of Swiss innovation policy and funding in the long term. It wants to understand better how innovation models have changed by eliciting, in a first step, feedback from organisations of Swiss manufacturing and service industries and their research partners. The ultimate goal is to draw the necessary conclusions for innovation policy.

Insights into new and changing models of innovation will be collected in hearings to which selected participants will be invited to represent their constituency (e.g., industry, knowledge field) and answer and discuss a set of questions (see below). The outcome of the hearings will be made available to all participants and will be the starting point for further analyses and discussions.

Key questions of interest

All participants are asked to prepare answers to the following set of questions which may be shared with SERI and the organizers during or before the hearings orally and/or in writing:

1. Have innovation **activities** in SMEs changed in the last 15 years (since the financial crisis 2007-09)? For instance, has the importance of research and development (R&D) activities changed? Has it become more common to adopt or imitate innovations introduced by others, e.g., global technology or industry leaders? Has the importance of obtaining external knowledge (through knowledge transfer) changed?
2. Have the most important **sources of knowledge** and **participants/contributors** to the design and realization of innovation projects changed? Do SMEs work more with public/private, R&D/non-R&D, national/international partners? Have collaborations changed to being more often bilateral/multilateral (e.g., in clusters, networks) or of low intensity/high intensity?
3. Have innovation **projects** changed in any way, e.g., with regard to their structural characteristics (e.g., size, duration), aims, proximity to the core business, approaches, tools, but also likelihood of being successful?
4. Has the frequency (or importance) changed of:
   a. innovating **products** (goods or services),
   b. innovating **business processes** (any function related to the production, distribution/logistics, supplies, IT systems, or development of new products and business processes),
   c. **organisational** innovations of administration and management of the firm (e.g., workplace organisation, external relations),
   d. **marketing** innovations (pricing and revenue models, promotion, packaging, product placement, or product design),
   e. any other type of innovation, e.g., to raise **sustainability**, reduce the **climate footprint**, or increase the **social responsibility** of business operations.
5. What are the main **reasons** for these ongoing changes? What **consequences** have firms experienced, for instance, with regard to productivity, revenues, cost structures, supply chains, market penetration, market extension or the like?
6. What changes to **innovation policies** result from these dynamics? Do we need new measures for supporting innovation activities more effectively?

With this e-mail we invite you to participate in a hearing with SERI and its academic partners for this project. If this is not possible, you may send us your responses to these questions, preferably before the workshop date.

If you have further questions on the scope or content of this initiative or wish to suggest additional participants with relevant knowledge and expertise for your field, please, do not hesitate to approach any of the persons listed below.

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Appendix 2: Hearing summaries

Hearing 1: Metal, electronics, machinery, textiles

Participating experts:
1. Leonard Badet, Bobst
2. Pierangelo Gröning, EMPA
3. Philippe Hersberger, NanoTronic
4. Roland Hirschi, Micronarc
5. Patrik Hoffmann, EMPA
6. Alain-Serge Porret, CSEM
7. Robert Rudolph, Swissmem

Written input:
8. Emanuele Carpanzano, Supsi
9. René Puls, Swiss Aerospace Cluster

Online input:
Rolf Gerdes, Inspire

1. Have innovation activities in SMEs changed in the last 15 years (since the financial crisis 2007-09)?

For example, has the importance of research and development (R&D) activities changed?

Has it become more common to adopt or imitate innovations introduced by others, e.g., global technology or industry leaders? Has the importance of obtaining external knowledge (through knowledge transfer) changed?

The year 2009 was not necessarily a game changer. The trend towards more competition, especially from Asia, a greater digitalisation of products and services, more complexity in terms of dealing with different technologies, had already started before then. This led to a shift in the innovation paradigm towards the speed of innovation, a stronger focus on innovation systems rather than a technology deepening, a change in the skill requirements for employees and a stronger focus on incremental innovation. In addition, collaboration with large players in the software market, such as Microsoft, but also with other institutions like Inspire, the UAS, or the ETH Domain became increasingly important. These trends partly led to a) a greater heterogeneity in terms of R&D investment intensity in SMEs, with some investing less and some investing much more in R&D, b) stronger focus on incremental innovations (in the technological sense), c) the increased pressure to reduce payback time, and a shift from technology-driven to value-driven innovation, d) stronger focus on combining technology with new business-models. Moreover, the complexity of the innovation process increased, requiring a more holistic research approach to determine where new developments make sense. Such systemic, holistic views on innovation activities were necessary to escape international competition. This required additional skills that were difficult to get, in particular for SMEs. A pure focus on improving technological performance was no longer sufficient to prevail on international markets; Asian companies can do this as well. This „transformative“ process was driven (internally) by companies and not by external organizations. The proximity of the production site,the development facilities and the internalization of R&D became important (only non-core (knowledge, technology) and parts were outsourced to other companies). Outsourcing production abroad could jeopardise technological development capacities in Switzerland. Nowadays, it is less about producing a technologically better product but more about creating more value by making it more digital and sustainable, and improving a service by using digital technologies.

2. Have either the most important **sources of knowledge** or the **participants/contributors** to the design and realization of innovation projects changed?

Do SMEs work more with public/private, R&D/non-R&D, national/international partners?

Are collaborations now more often bilateral/multilateral (e.g., in clusters, networks) or of low intensity/high intensity?

The cooperation with all types of partners has increased over the last decade. SMEs are looking for more intense, more reliable lasting relationships. Strategic partnerships (e.g. with institutions such as Inspire), which are designed for a longer period of time, have gained in importance as exclusively in-house R&D projects have become too expensive and risky for SMEs; moreover, they often look for complementary skills. Participation in innovation consortia is often seen as a solution for short-term innovation projects. However, not only is the intensity of cooperation increasing, but also the diversity of cooperation partners involved, as more advanced innovation projects require the participation of companies/institutions along the whole value chain. This requirement also supports the trend towards ecosystems that go beyond a (brick and mortar) innovation competence centre. Key drivers for this development are digitalisation, standardisation (the need for functioning interfaces) and the requirements for greener, sustainable products.

The framework conditions for a more intensive and diverse cooperation are not optimal in Switzerland. a) SMEs are more affected by Switzerland's exclusion from Horizon Europe. Unlike large companies, they cannot relocate their projects to Horizon Europe eligible countries. The general financial guarantees provided by the Swiss administration are not sufficient. European partners (quite often) require a written guarantee that the Swiss administration will finance the Swiss share once a project has been approved. b) Cooperation partners such as EMPA focus more on large companies and start-ups, and less on SMEs which need cooperation for incremental innovations. Often, SMEs do not know how to contact institutions like CSEM since access seems to be difficult (lack of contacts, lack of know-how) and the administrative burden too high. Property rights are a big problem in collaborative projects, especially with public research institutions like the ETH They have an interest in ensuring that publicly funded research remains public and not be privatised and thus remain inaccessible for future basic research. This is less of a problem for institutions like Inspire which have no interest in property rights. Very often SMEs forgo expensive patenting because they can hardly enforce their rights against large companies. It was also discussed if large companies should be forced to share their knowledge with SMEs in the form of open licenses. The successes of Innosuisse in promoting ecosystems/multilateral cooperation are not yet visible.

3. Have innovation projects changed in any way, e.g., with regard to their:

a) structural characteristics (e.g., size, duration), b) aims, c) proximity to the core business, d) approaches, e) tools, or f) likelihood of being successful?

Managing the risks of an innovation project became more important. This led to smaller, agile projects focused on incremental improvements and product development (instead of research-based innovations), shorter time-to-market, which significantly shortened product life cycles overall. Testing or co-developing new products with customers as quickly as possible also gained in importance. Customer value orientation became more important. Increasing time pressure was forcing some companies to focus more on their core innovation competencies and to try to partner with external partners to acquire complementary capabilities. This was somewhat at odds with the sometimes expressed need for more transformative, research-based innovation projects to remain internationally competitive. Here in particular, a response from public support measures was partly expected. Currently, public support is increasingly flowing into BRIDGE projects that are more science-oriented. This reduces the funds available for traditional Innosuisse projects, which lowers approval rates and discourages especially smaller companies from applying for technology development projects. In other countries, the funding measures

are sometimes more attractive, prompting companies with foreign production facilities to relocate their development to such locations; it is likely that research will follow suit - at least in part.

4. Has the frequency (or importance) changed of:

a) Innovating products (goods or services), b) innovating business processes (any function related to the production, distribution/logistics, supplies, IT systems, or development of new products and business processes), c) organisational innovations of administration and management of the firm (e.g., workplace organisation, external relations), d) marketing innovations (pricing and revenue models, promotion, packaging, product placement, or product design), e) any other type of innovation, e.g., to raise sustainability, reduce the climate footprint, or increase the social responsibility of business operations.

Yes, the frequency has changed. In the past, you had, let's say, 4 years to develop a new product, today it has to happen much faster. We have moved to a step-by-step approach, where the whole innovation process was broken down into smaller, agile steps. In addition, improving the performance of machines (products), e.g., by increasing throughput, is no longer the primary goal. We need to combine (quite often) new products (technologies) with artificial intelligence and machine learning components with new business models. The energy consumption of a machine, digital connectivity, or new service models such as "pay-per-use" systems are becoming increasingly more important. The service component in innovative products is becoming more and more crucial. The trend towards more sustainable products is an important driver for these developments. This is particularly challenging for SMEs, as they lack the resources to invest in marketing and the visibility of their innovation’s environment-friendly component is less. Marketing is a crucial factor for the "perceived" value of innovations, especially in the field of "sustainability".

5. What are the main reasons for these ongoing changes?

What consequences have firms experienced, for example, with regard to productivity, revenues, cost structures, supply chains, market penetration, market extension or the like?

Basically, all the factors mentioned are important. However, we should add EBITA. More and more, many companies are turning to technologies developed by other companies, such as Microsoft. Especially companies that operate in international niches often want to cover the entire process chain themselves. This requires a high degree of automation in order to reduce personnel costs. However, this does not mean that skilled workers are laid off, rather they are upskilled. In particular, SMEs in peripheral regions lack skilled workers. Graduates from universities such as the ETH prefer to work on modern technologies such as AI or ML, and consequently, it is difficult to find professionals for activities such as precision grinding, which has a high added value. There are also more general drivers such as pandemics, wars, competition for energy and raw materials that force companies to change and innovate their business models and production processes.

6.What changes to **innovation policies have** resulted from these dynamics?

Do we need new measures to more effectively innovation activities?

In principle, there is no need for additional support instruments, such as direct subsidies. However, the existing instruments should be improved and made more visible, especially for SMEs. The promotion of basic research and start-ups works well. The exclusivity of the results of Innosuisse-funded projects is also highly appreciated and differs from innovation funding measures in other countries. However, Innosuisse funding focusses too strongly on start-ups and increasingly neglects "classic" SMEs. Inno-

suisse funding should also include academic partners from abroad. It should also more strongly recognise the importance of "holistic" innovation approaches. Project funding should be differentiated in terms of time. Funding is needed for short-term projects aimed at the rapid commercialisation of innovations, medium-term projects and the (riskier) longer-term projects that focus on more fundamental improvements, especially those related to the challenges of greener products and production methods. Regarding the latter, many SMEs do not yet have a clear idea of what this shift towards sustainability means for them. Effective promotion should also take into account the importance of combining new products and new business models. It was also noted that access to research at the ETH and the EPFL is becoming increasingly difficult. The patent policies of these institutions are becoming more complicated and thus are less attractive for SMEs. Access to the universities of applied sciences, CSEM and EMPA is easier for SMEs. The BRIDGE projects, on the other hand, are too focused on start-ups as well as basic research and are not open for SMEs. The patent box is useless for many SMEs; it favours start-ups because patents make them more attractive for larger companies. So, in the end, it is mainly large companies that benefit from the patent box. SMEs prefer to keep their intellectual properties secret.

Hearing 2 Med-tech, bio-tech, plastics

Participating experts:

10. Jens Krauss, CSEM
11. Magali Bischof, BioAlps
12. Erik Schkommodau, Hochschule für Life Sciences FHNW
13. Christophe Bally, CTC Resourcing Solutions AG
14. Matthias Peterhans, ender diagnostics ag
15. Frank Nüesch, EMPA
16. Julie Risse, Sitem Insel

Written input:

17. Daniel Delfosse, SWISS MEDTECH
18. Michael Altorfer, Swiss Bio-tech Association
19. Jens Krauss, CSEM
20. Beat Lechmann, J&J Innovation

Key questions of interest

1. Have innovation activities in SMEs changed in the last 15 years (since the financial crisis of 2007-09)?

For instance, has the importance of research and development (R&D) activities changed? Has it become more common to adopt or imitate innovations introduced by others, e.g., global technology or industry leaders? Has the importance of obtaining external knowledge (through knowledge transfer) changed?

After 2010 big companies changed their R&D. It had to become more efficiency-driven and the R&D departments had to deliver more and quicker. With the stronger focus on the return to R&D and the delivery of results, an “early follower” strategy became more common: the companies waited for technologies to work or even succeed on the market and then they bought the start-ups which introduced them. Large companies in pharma, bio-tech, and med-tech were not doing more R&D, but were scouting more for new technologies and their inventors in order to buy the start-ups or the other companies. Companies bought more firms and technologies as they wanted to reduce the risks that came with engaging in R&D. Larger med-tech firms followed the example of big pharma and also started to scout more for new technologies and firms.

The importance of R&D has always been high in the Swiss med-tech industry and Innosuisse projects are as important as always. According to the surveys conducted for the Swiss Medical Technology Industry, the R&D intensity of med-tech companies has grown from 12% in 2007 to 17% in 2013 among manufacturers, then decreased to 8.5% in 2017 and rebounded to 10.5% in 2021. The trend is different for suppliers which spent only 5% on R&D in 2007, increasing to 13.4% in 2021 (after a dip from 12% in 2015 to 7.5% in 2017). The more recent increase in R&D across all industries since 2019 might be due to the tax reform which permitted a maximum deduction of 150% of the effective R&D expenditures (upon cantonal approval).

Regulatory issues are key for med-tech SMEs: the new EU regulations from 2017 increased the regulatory burden (see question 3 below). It is not easy for Swiss firms to get their products approved by EU regulators. New firms need the CE mark and, therefore, chose the location where they could find it the easiest place to enter the market.

The cost pressure in the health system is important as well. It is often difficult to gain a foothold in the market with a new, more expensive product, especially if there is a cheaper alternative with the same effect. The profitability of medical innovations has changed, and it now takes longer to generate revenue

due to the medical payment system. The goal is no longer to make products better, but to make them safer. On the other hand, it was also mentioned that digital health tools were empowering patients and users and the ability to demonstrate the impact of care and services was becoming more important.

2. Have the most important sources of knowledge and participants/contributors to the design and realization of innovation projects changed?

Do SMEs work more with public/private, R&D/non-R&D, national/international partners? Have collaborations changed to being more often bilateral/multilateral (e.g., in clusters, networks) or of low intensity/high intensity?

In med-tech, approximately 1/3 of all innovations comes from internal sources, 1/3 from collaborations with universities and 1/3 from collaborations with and purchases from other companies. All in all, collaboration is more important today than it was 15 years ago. As the complexity of innovating grows, more and more firms are looking for external help than ever before.

Technology scouting has become more important. Open innovation platforms are used to scout for valuable technologies and start-ups. Networking and cluster organizations are being approached by SMEs with requests for assistance in knowledge and technology scouting from early scientific insights to advanced solutions.

For public research organizations (PROs) push and pull has not changed as starting points for collaborations with the private sector. Push transfers, i.e., PROs looking for customers for their research results and technologies, often encounter reservations from companies because they are too far removed from the market. Pull transfers are often triggered by a desire to understand technological systems better for which scientific R&D is needed.

Good universities and universities of applied sciences (UASs), qualified people, political stability are important location characteristics that make Switzerland still attractive. However, Switzerland lacks a portfolio with visible RTOs (Research and Technology Organizations), like Fraunhofer, Helmholtz etc. in Germany which focus on applied research and technology development. CSEM perceives a growing demand for its services, but in the German-speaking part of Switzerland, its strong competences in the field of microelectronics and -technology are sometimes overlooked. Competences in the ETH sector or in large research organisations tend to be hidden from the outside because they are more advanced and current research topics do not reveal what else the organizations know. Numerous public and private initiatives (such as innovation parks, innovation centres, innovation hubs, etc.) add to the non-transparent jungle of players. Therefore, companies struggle to find the entry or starting point, above all SMEs. Big players, e.g., large pharmaceuticals, have better access to the universities, and they can absorb all the university/ETH capacities for technological work. SMEs find closed doors and they struggle both with the “translation” of their needs to the scientists and with the adaption of the scientific results to their needs.

Art. 15 funded-organizations like sitem aim to bridge the gap between universities and firms, e.g., by offering an open innovation platform, but companies are more interested in direct scouting than in the more abstract ecosystem.

3. Have innovation projects changed in any way?

e.g., with regard to their structural characteristics (e.g., size, duration), aims, proximity to the core business, approaches, tools, but also likelihood of being successful?

The time-to-market and the necessary investment for medical product development have at least doubled (+2 years) when compared to the time before 2017. A class 2 product in med-tech (e.g., dental implant) now takes 10 years from the beginning of the Innosuisse project to market entry. Two changes

have driven this: 1) Under the new regulations (medical device regulation (MDR) and in-vitro diagnostic medical devices regulation (IVDR) introduced in 2017, the importance of clinical data has drastically increased. A pre-clinical proof-of-concept combined with an equivalency to an existing product is no longer sufficient to obtain a CE-mark. Therefore, all new medical products must go through a clinical phase before they can be put on the EU market. The Health Technology Assessment (HTA) wants a stronger emphasis on the compilation of systematic scientific pre-clinical and clinical data which supports safety, efficacy, and performance claims. The approval times for new products or services that draw on AI or machine learning have increased as the regulators need more time and effort to certify the algorithms and data. 2) The complexity of med-tech products has thus grown, as it incorporates engineering, biology, computation etc. This complexity drives costs and requires collaboration, as companies do not have all the in-house knowledge needed for innovation. Ideally, academic institutions collaborate early on with the manufacturers who support regulation conformity and have market access. In theory, this could be an advantage for Switzerland as well, as good research organisations could bring the different knowledge areas together and the good repositories of patient/clinical data could be used to attract businesses (if interfaces can be generated).

IP protection is important in pharma and bio-tech. With regard to med-tech, the importance of IP was perceived differently, and some participants stressed its key role for start-up companies. The importance of product regulations was unanimously stressed. The role and importance of data is still being overlooked and to some extent is still being ignored in Innosuisse projects. Rules for open data access, guaranteed availability (protecting privacy) are needed. However, the handling or processing of such data is, in many cases, already a challenge, maybe even more than having data access. Data management and access are business opportunities in the med-tech sector. New knowledge that is needed for innovation relates above all to IT systems, clouds, e-commerce which is less common among universities and even more so among private innovation partners ("I would not know whom to approach in a university."). IT skills are needed to accommodate more customer-oriented approaches. This also means that innovations are no longer purely technological. Med-tech firms need to build up software departments to compete. If they don't, they will be purchased and their knowledge will be moved to the US. All in all, the digitalization processes in the Swiss med-tech industry are perceived as being (too) slow causing it to lose ground in the digital transformation of the healthcare system.

4. Has the frequency (or importance) changed of:

a) innovating products (goods or services), b) innovating business processes (any function related to the production, distribution/logistics, supplies, IT systems, or development of new products and business processes), c) organisational innovations of administration and management of the firm (e.g., workplace organisation, external relations), d) marketing innovations (pricing and revenue models, promotion, packaging, product placement, or product design), e) any other type of innovation, e.g., to raise sustainability, reduce the climate footprint, or increase the social responsibility of business operations.

The hearing participants did not agree on the importance of product innovations. Some suggested that for some years R&D has already focussed on process improvements and the solving of regulation problems. A lot of innovation was done in the production chains. Growth had sometimes been achieved through vertical diversification in the value chain, i.e., the production of their own equipment and tools. In the more recent 2-3 years, digitization might have brought the focus back to products SMEs again place a stronger focus on improving products and on doing incremental innovation. Other participants stressed that with regard to digital health, many technology-driven start-ups have emerged, most of them developing and commercializing new product concepts.

The importance of services or new business models has also grown as additional opportunities for technological innovation have been limited. More often, companies build services around their products instead of innovating new products. The advantage is that in service businesses, the market success is more quickly revealed, scaling is easier, and revenues come in much faster. Service and business

model innovations tend to be outside of a company's R&D/innovation activities and budgets and might not show up in innovation statistics.

5. What are the main reasons for these ongoing changes?

What consequences have firms experienced, for instance, with regard to productivity, revenues, cost structures, supply chains, market penetration, market extension or the like?

Several drivers of change have been perceived in the health sector: 1) The increasing density of national and international regulations in this sector was already mentioned with the new EU MDR/IVDR regulations. For bio-tech, the extensions of the Nagoya protocol (e.g., Digital Sequence Information) are more important. This raises the uncertainty related to R&D projects conducted in Switzerland. 2) The discussions on the global IP framework (see e.g., the TRIPS waiver discussion), also increases uncertainty and undermines the trust of investors and entrepreneurs. Trust in IP protection is critical, as projects are very long-term and costly. 3) In Switzerland, the strong focus of hospitals on cost effectiveness, revenues, and profits rather than on finding the best treatments, e.g., by engaging in clinical trials, also matters. The payment system for medical services ("Tiers") does not incentivize innovation. If a treatment gets cheaper, the insurance tariff goes down. Hospitals have no real interest in better treatments, if they drive costs up. As a consequence: It is easier to find funding to reduce costs than to invent new products. Doctors lose opportunities to stay involved in clinical R&D and, therefore, move abroad where they can treat patients while serving as clinical investigators staying close to clinical R&D. Hospitals abroad (e.g., in the US, Denmark, or Germany) pride themselves on the fact that their patients have access to the latest clinical R&D, Swiss doctors have to beg for forgiveness if they spend more time on clinical trials rather than use the time in a more cost effective/revenue generating manner. 4) Technologies with innovation potential are too often sold at an early stage of development, rather than their being taken all the way to commercialization stage. Investors and entrepreneurs "play it safe" and sell an innovation in an early stage to investors and companies from abroad.

6. What changes to innovation policies result from these dynamics?

Do we need new measures for supporting innovation activities more effectively?

Several points from the discussions bear some consequences for innovation policies:

1) For SMEs, it is challenging to write up a project or fill in a form for funding. Innovation funding should reduce the administrative load for scientists and firms. Currently, all changes in funded projects need to be reported. The funding process should become less formal, less time-consuming, with more freedom. Funders, e.g., Innosuisse, could have more trust in scientists that they generally try to make the best use of the allocated funds. Micro-management and controlling take away a lot of time and energy from the project participants.
2) Companies should be free to choose the best R&D partners and not be limited to universities and universities of applied sciences. Direct funding to SMEs would be helpful to lower the private risks of innovation projects and generate a first signal for valuable projects. It was also mentioned that the difficult relationship with the European Union and resulting the insecurity or the total lack of access to European R&D funding reduces the room for manoeuvre for SMEs.
3) Providing support to start-up companies is important, otherwise there wouldn't be any innovation. In this context, the Swiss start-up ecosystem has been described rather negatively as a "closed, self-funding tool for experts and coaches with endless events, kick-starters, prize winners, etc." Some countries (e.g., Australia, South Korea) fund start-ups which have proven the market feasibility of their technology or product. Why not subsidize prototypes/MVPs in SMEs and start-ups? Bridge does not do this, as it is too early in the value chain.
   However, it should be guaranteed that a start-up's knowledge stays in Switzerland and that it cannot be bought by big players from abroad. This would be the case if they received public support

in their early phases. Direct (public) investment in start-ups might come with some “strings attached”. This is done partially in tech transfers by RTOs which have clauses in their licence contracts.

A counter argument in favour of international collaboration was also made. Collaborating with globally active companies might provide start-ups with access to know-how and experience on market entry, distribution, and markets, as well as on regulatory affairs.

The lack of significant early-stage funding for start-ups is seen as problematic, as it leads to a longer R&D phase until proof-of-concept. In addition, due to the fragmented investor base of angel investors and small local VC funds, it also reduces the attractiveness of start-ups from the perspective of larger players.

4) Compared to RTOs abroad (e.g., Fraunhofer), the UASs are absorbed in teaching, and non-university RTOs (e.g., EMPA, CSEM, Inspire) work in specific fields and there is no national strategy to make their knowledge usable in a productive manner. The number of organisations and initiatives in the Swiss research and innovation system has grown, and companies are confronted with a jungle of institutions. Funding can also play a role. It can incentivize organizations not to do the most relevant projects but the ones that are funded. Network building should be more supported (e.g., Sitem is too focused on being able to finance itself rather than being able to put the necessary resources into establishing networks). Institutions like Inspire or CSEM should have long-term financing (and not just 8 years) and be able to participate in publicly funded innovation projects at their full cost.
5) Several participants stressed that there should be a stronger focus on funding digitisation initiatives that develop visibility and broad impact and also spill over to the entire industry, including the management of and access to patient/clinical data.
6) Due to new regulations, clinical studies are also needed for med-tech products and the support of such studies by Innosuisse is important. Funding for med-tech innovation must therefore cover two phases: a first phase (pre-clinical proof-of-concept) and a second one (clinical study with patients). A GO/NOGO gate should be introduced between the two phases and the projects passing the gate need to be further supported during the clinical study phase.
7) Coaches are helpful to bring players together, even if some coaches might be bad. A solution would be to accredit them.

Hearing 3: IT products, IT services, watches

Participating experts

21. Stefan Metzger, Digital Switzerland
22. Guido Schuster, Ostschweizer Fachhochschule OST
23. Christian Grasser, Swiss Telecommunications Association (asut)
24. Jonas Baer, Bandara
25. Fabienne Marquis, Association suisse de l'industrie horlogère

Written input

26. Nicola Rohrseitz, MSD
27. Pierre Fazan, IMEC
28. Judith Bellaiche, Schweizerische Wirtschaftsverband der Informations-, Kommunikations- und Organisationstechnik SWICO
29. Michel Benard, Consultant

Key Questions

1. Have innovation activities in SMEs changed in the last 15 years (since the financial crisis 2007-09)?

For instance, has the importance of research and development (R&D) activities changed? Has it become more common to adopt or imitate innovations introduced by others, e.g., global technology or industry leaders? Has the importance of obtaining external knowledge (through knowledge transfer) changed?

A – The global landscape has evolved. The consequence is that innovation activities which previously seemed reasonable started to appear as a waste of time and money. And this despite that their need, nature, and potential impact remained fundamentally unchanged. Harder to justify R&D expenses, less money available.

As R&D can't guarantee return, it then generally decreases.

Resources for innovation are becoming tight and this lack of resources is important. For business innovation, we need other companies than just the technical ones. SMEs can't build an innovation department.

The priority is to make operations more efficient, because going further is very risky and difficult. This delays innovation processes.

Outsourcing innovation is increasing (e.g., Mobiliar, Consulting companies).

Three ways to innovate / portfolio view:

- Efficiency innovation
- Sustaining innovation
- Transformative innovation – renew an industry, shape an area

Companies in Switzerland should try to innovate more transformatively. Very few SMEs try to be disruptive.

B - M&A is often viewed as a less risky and a better financially quantified investment than R&D organizations and facilities. The trade-off «Make or Buy» is often biased towards «Buy».

If a company, i.e. start-up is integrated into a larger company, innovation momentum then decreases because there is no need to keep coming with new ideas. The start-up becomes a wheel in the system that needs to work as expected within the other organisation. That's the Innovators' dilemma.

C -A strong point is the development of start-up thanks to an efficient ecosystem, which is observed by investors all over the world. These start-ups can be innovative outside of the traditional R&D process. Thanks to this, high investments, product development and access to market are successfully supported in areas such as quantum computing, security, AI, etc. These technologies have the potential to drive Switzerland to the top of innovative countries. But potentials must be realized and there are problems and gaps – in particular, regarding highly skilled workers in the considered areas. Our present advantages are decreasing.

The culture is changing in the right direction. More students want to create their own companies.

Start-up cultures are already infused with engineers during their studies. The younger generation wants to found start-ups. Today there is a desire among many students to found a company. There seems to be some change happening.

The culture in the US is different. Swiss engineers want to work in a large company. In CH, risk aversion seems to be strongly felt.

But why not create a new unit inside an already existing business? Why not fund start-upers (young academics/professionals eager to found a start-up) inside SMEs?

It's already there: Dedicated innovation teams who have the attention of senior management

The Ecosystem is strong, but it is a cultural issue. What are we strong in (meaning the Swiss innovation system)? Switzerland is hardware focused.

People avoid failing, it is a cultural thing. Though a cultural shift already seems to be in progress, more awareness that failing is an option needs to be built.

D- For the watch industry, it is important to maintain the link to the customers. Digitalization is new for our industry as well as the pressure on the resources. Innovation is taking place more in subcontractor firms. SMEs are innovative in their production and processes, even business models, but traditional fields are maybe different.

Many companies have no clue about what customers are doing with their products (e.g., watch industry)

If you put sensors in a watch, you would have data on how customers use the product, laying the basis for innovation.

Watch industry missed out on the second hand market.

Use digital means to keep the customer during the lifecycle of the product. However, digitalization is a complex operation for the watch industry and the SMEs. They need help to master it.

We have been going through crises before, what is now new:

*the pressure on the resources, including human ones

2. Have the most important sources of knowledge and participants/ contributors to the design and realization of innovation projects changed?

Do SMEs work more with public/private, R&D/non-R&D, national/ international partners? Have collaborations changed to being more often bilateral/multilateral (e.g., in clusters, networks) or of low intensity/high intensity?

A-Industry-academia collaborations are becoming more and more popular, as they represent a less costly alternative to internal R&D in terms of FTEs, computing resources and other expenses. If well targeted and managed, these collaborations can bring significant value to the firm.

Open innovation in large firms is the rule in order to monitor and implement start-up innovations. This was just not considered 15 years ago – open innovation is now key for international competitiveness.

The dynamics changed towards more collaboration between research and industry. But one important fact to keep in mind is that academia can very well do research investigations, prototyping and sanity checks, but can never offer an alternative to internal product development.

FHs are still very important. They have more innovation projects because it is important for their evaluation / rankings. Maybe FHs are more open because they are not assessed (exclusively) based on their publications

Research partners consider what's in it for them to cooperate with an SME compared to having another publication.

B- The design and realization of innovation projects have become more professionalized in the last 15 years. The opportunities (honeypot) for EU grants for the academic-industry consortia gave rise to an array of service providers, events, training. What is most worrisome, though, is that these support services are contributing to successful grant proposals. Worrisome because the grant writing abilities and actual innovation impact can only be loosely correlated at best. Successful grants, independent of their potential, can also go astray through excessive rigour in project management. The same criteria that can contribute to winning a grant can at the same time be the cause for project failure.

For example, information on how to write a successful proposal and to run a project is more available than ever. Even too much. This is a problem. This creates a distraction from working on the actual innovation.

C- the US tech firms play a great role in innovation – even if this happens in Switzerland. International cooperation is of great interest. The location of US tech companies strengthens the formation of clusters and the attractiveness of Switzerland regarding international talents. Here, both the ETHZ and the EPFL play an eminent role.

International software companies play an important role. They offer technical platforms and bring the know-how

Companies like Huawei:

- Realized telco market is limited
- Start transferring their knowledge to other sectors
- Transferred their knowledge to Switzerland, software and hardware
- Their software solutions and platforms are similar for all fields of application
- Swiss companies get resources and know-how

D- Micron Technology, does more innovation externally. Innovation is done by collaborating with universities, research consortia, suppliers and also with customers. In the past, innovation was carried out more internally. We don't change by copying others, we innovate by focusing on specific areas of expertise. For example, we rely on collaborations with universities to understand the fundamentals, then we focus on applying this knowledge to product definition and to developing a product. For sure, it is more important than ever to obtain and leverage external knowledge.

Collaborations are also changing a little bit. We prefer a bilateral collaboration rather than big multilateral projects. In some cases, we still like consortium-based R&D activities when the focus is correct. To be focused is as central as time is important in innovation. We prefer to directly fund a university project with very specific goals rather than joining a largely publicly funded R&D project with a less targeted

goal and with a lot of bureaucracy. As an example, we completely stopped our participation in EU projects. We replaced them with specific university projects (MicronTech).

E-Association Suisse de Recherche Horlogère identifies subjects for common research projects, mostly in CH:

- Looks for partners for research,
- Feeds insights back to companies,
- What is new: more attention is paid to what we can do together,
- Today, they are more cautious about what they spend money on.

3. Have innovation projects changed in any way, e.g., with regard to their:

a) structural characteristics (e.g., size, duration), b) aims, c) proximity to the core business, d) approaches, e) tools, or f) likelihood of being successful?

The new global innovation landscape is less formal, less structured, has less patents, and just plainly go through typical trial-and-error much faster. Shiny examples like Space X and Tesla have demonstrated that software-centric methods and cultures can have a profound impact even in conservative industries.

A-Software and connectivity became everyday elements:

Software has impacted us profoundly both in terms of expectations for what technology can do and in terms of how we can work. Software is at the core of every innovation.

Every new activity is naturally compared to the latest app and launching a flawed product that is refined on a weekly basis is an accepted norm. How these products and services are created, however, has not reached most of the class- and boardrooms.

Additionally, the world's information and social network have changed the way we can work, they also brought a deluge of information and attention spans have been reduced.

Combined, the progress of portable computing has a negative effect on traditional innovation activities such as projects, R&D, patenting. For instance, deciding on which bets to take has become harder. And being unable to decide reduces the KPIs of innovation.

B-Innovation needs to be iterative and more customer-centric – the growth of business model innovation amplifies the customer-centric nature of innovation. Agile cooperation with customers and product/process adaptation are key.

It is important to let innovations to be "experimented" with in the real economy – particularly if they are customer-centric. These are real experiments (experiments in real life) which need to be supported by adequate regulations and institutions

Support experimentation:

- FHNW labs for virtual reality, or a robotic lab
- Should companies have such labs, too?
- Early-stage experimenting is great, but how to connect with customers and their needs? This is very hard in labs.
- You need the real economy to test ideas and innovations, e.g., Uber, which is not possible in a lab.
- In the US, the society is maybe more ready to accept real world experiments.
- In Europe, society expects ex-ante regulation which stops real world experiments. This seems to be the wrong way.

C-Remote activities (meetings, networking, collaborative works) as well as new tools for advanced engineering, product development and design, etc.. have been developed – partly during the pandemic

crisis – this accelerates innovation processes. We cannot spend years on something nobody wants. The innovation cycle is faster in digital products (than in an engineering environment)

Faster, cheaper, better. Cheaper through government subsidies but that can make them slower!

It is easier to have an annual renewal of smaller projects. That way we can easily adjust goals and focus and have a better match with our needs. For consortium type of activities, this is more long term, with typically 3-year long engagements that are then renewed (MicronTech).

D-Portfolio strategy – firms need to pursue a broader range of innovation projects and to fund R&D in a staged manner, as opposed to all at once. Firms can increase the breadth of supported projects by providing limited funding to a larger number of projects. Greater breadth in funding should then be combined with interim evaluation of funded projects. Some will be discontinued in order to provide more promising projects with sufficient resources.

*With 1000 employees, it should be possible.

*It would be better have 2 or 3 projects than just one very expensive one that in the end nobody is interested in.

E- The relevance of traditional innovation KPIs as a proxy for innovation strength needs to be revised. For instance, the number of products vs the number of patents is likely a more contemporary proxy.

Switzerland is rated at the top for innovation but not so much for products introduction. Switzerland is good in basic research, patent creation, start-up founding but less good when we need to grow a company and implement the innovations in real products. Maybe this is linked to the size of the country and market size availability. An idea would be to support the next step after innovation which is product, ramping volume production, etc. Singapore is small country which is doing well in this area.

4. Has the frequency (or importance) changed for:

a) Innovating products (goods or services), b) innovating business processes (any function related to the production, distribution/logistics, supplies, IT systems, or development of new products and business processes), c) organisational innovations of administration and management of the firm (e.g., workplace organisation, external relations), d) marketing innovations (pricing and revenue models, promotion, packaging, product placement, or product design), e) any other type of innovation, e.g., to raise sustainability, reduce the climate footprint, or increase the social responsibility of business operations.

A-BMI becomes central and is more customer-centric that product/process innovation

Business model innovation needs newer and more different competences than what is required for product or process innovations. Traditional companies struggle with business model innovation

Scaling is key for business models. Cloud tech is enabling other tech companies and research for scaling up

Business model innovation, do we have the people for that? Developing new business models is a cultural issue, requires new HR**.** Are we training business model innovators?

Small departments at the EPFL and the ETHZ

B -MicronTech: Products: yes, as we constantly develop new tech and introduce new generation of products (it used to be 18 months for a new node, now it is every 12 months or less)

Business processes: I assume, the answer is yes. We introduce more automated tasks, we are leveraging AI and exploiting big data analytics.

Other type of innovations: sustainability is required as well as the desire to be carbon neutral. We also try to innovate with respect to the workforce, to attract talents.

5. What are the main reasons for these ongoing changes?

What consequences have firms experienced, for instance, with regard to productivity, revenues, cost structures, supply chains, market penetration, market extension or the like?

R&D in IT companies has been subject to growing cost pressures – particularly since 2007-08. Companies are mostly measured against short term profit goals (quarterly results for firms on the stock market, and 1-3 years investor's profit goals in the case of private companies). CEO and executives are compensated based on these results, and therefore, are often reluctant to invest in long term R&D goals.

The US industry has greatly increased its presence in Switzerland and undertakes R&D among other things. Global innovators also manage from Switzerland sales and organization and support user (consumer centric) innovations in all sectors. For example, cloud technology is an important enabling technology for innovation in any sector. It is clear that big R&D is done by the US firms based in Switzerland. The Swiss SMEs are innovative but focus on design and the implementation of products and services.

Potential entry in IT and other application markets by GAFAM which is a source of disruption – it is not obvious how SMEs can respond.

Strong competition comes from all over the world, so we have to be the best in hiring, in being effective, in innovating, in bringing new product to the market. Implications: flexibility, continuous fast changes and great market responsiveness. Our improvements (flexibility, fast changes and market responsiveness) have allowed us to stop losing money during downturns and have allowed us to be more competitive. But constant evolution, never frozen models or situations.

The fear of losing market is a driver for innovation. SMEs are afraid of losing market share, of missing out**.** If you want to motivate them to do something, tell them their competitors are working on it

Market penetration is a driver.

6. What changes to innovation policies result from these dynamics?

Do we need new measures for supporting innovation activities more effectively?

Policy rationale: The ICT industry in Switzerland has a good reputation & a high attractiveness. It is a young industry which has been playing a central role in the economy since digitalization became the core of any innovation.

ICT industry plays a great role in supporting companies in all industries and increasing organizational resilience.

A-Innovation needs more IT experts. This was not the case thirty years ago. There is a huge shortage of human resources and experts in these fields. Large companies are able to attract top talent, but SMEs and even academia are struggling to hire IT experts. We lose people to Facebook since we can't pay competitive wages.

This trend has been recently mitigated by a workforce demanding more "meaningful" jobs, often oriented towards sustainable projects rather than profit-only-ones. So, IT companies pursuing explicitly some social goods (in parallel with profit activities) can play their card.

Key competences involve data science, software. If you don't have staff with such profiles, you can no longer innovate. There is a labour market problem – SMEs can't pay the same level of salary as Facebook.

Switzerland is strongly dependent upon foreign talents. There is no alternative to building our own talent pool, in particular through the promotion of STEM disciplines. Our education system has not adapted to such a strategy and this includes vocational education & training (VET). Here some specific recommendations are needed.

Theory on reasons for lack of IT-professionals: After gymnasium (higher level secondary school) going to the FH is made difficult and two options exist: either you study at a world class IT university or you don't go to university at all. There is no medium-tier university in IT in Switzerland. A path should be opened via a FH, to become a top engineer at a medium tier school.

B- The speed of innovation in the new landscape makes a number of existing innovation policies ineffective simply because they take too long. Even in the case of successful outcomes, their impact is by and large insufficient when taking into consideration the time it took for planning, evaluation, approval and execution. Going from inception to conclusion can easily take more than 2 years. Besides an insufficient impact vs duration ratio, an indirect consequence of long duration and of a "project mindset" is that fruitful trial and error loops take too long and deviations from the plan are not encouraged even when necessary in the larger scheme of things.

What policies would accelerate innovation? Not a faster horse! This means, new approaches are needed.

What needs to be ensured are an increase of specialist ideation and quicker trial-and-error feedback loops. The first is the root of science-based innovation: technical people must have natural tendency to improve their work through better methods, products, solutions, organizations. Then testing these ideas must be allowed to be happen quickly, blessed by managers who understand the potential upside and what can be done to improve the chances of success. In other words, an entrepreneurial mindset must be developed in specialists and a VC mindset must be developed in managers. A consistent policy would be the introduction of appropriate curricula in middle schools, as well as subsidized post-grad certification courses.

Thanks to the pervasiveness of software, these courses needn't be theoretical or ex cathedra. On the contrary! Creating appropriate curricula that are based on computational thinking would open the vast opportunities of digitalization to current and future technical specialists. Creating simple but real digital products and services is a great mindset school. The resulting mantra on the workplace would then be: how can digital tech make this faster, cheaper, better? The impact of such an approach has the potential of reaching beyond innovation and improving the overall digitalization of Switzerland.

C-The Fraunhofer Society in Germany plays a central role in supporting innovation for SMEs and larger firms. Switzerland has smaller scale institutions (CSEM) and programs (Innosuisse).

Our policy and framework conditions are really good. Innosuisse instruments work really well, in global comparison. Innosuisse is efficient as it allows targeted projects that are more bilateral. Huge European projects are not very effective (at least for a company like MicronTech)**.** Innocheck is a good tool to experiment with. It should be increased to CHF 30,000. UASs could help Innosuisse if Innochecks were worth either CHF15k or 30k

The loss of our connection to the Horizon program is also weakening the positions of our universities.

More project funding with smaller fund/amounts. With Innosuisse, you can only have one project funded every two years. I wish for more communication about the promotion programs.

Vision: mechanism that build awareness in SMEs, early warning for market developments that could become big - e.g., metaverse, virtual clothing.

D-With start-ups, we do well, **awareness building and training could do the same for SMEs**

For start-ups, great programs for awareness building are already in place.

Hearing 4: Finance, fin-tech, Insurance

Participating experts:
30. Elli Androulaki, IBM Zürich
31. Thomas Brändle, Run my Accounts
32. Isabelle Cohen-Solal, Coherence Solutions
33. Richard Hess, SBA
34. Christian Maehr, UBS
35. Cornelia Stengel, Kellerhals Carrard
36. Marianne Wildi, HBL

Written input:
37. Roman Gassner, Glarner Kantonalbank
38. Stephanie Wickihalder, CS
39. Marianne Wildi, HBL

Key questions

1. Have innovation activities in SMEs changed in the last 15 years (since the financial crisis 2007-09)?

For instance, has the importance of research and development (R&D) activities changed? Has it become more common to adopt or imitate innovations introduced by others, e.g., global technology or industry leaders? Has the importance of obtaining external knowledge (through knowledge transfer) changed?

For a long time, innovation was carried out within banks. With the advancement of digital technologies, the availability of big digital data, and the disruptive (radical) innovation from outside banks, especially in fin-techs, the traditional architecture of banks is now often perceived as a barrier to more disruptive change. Banks have cut their R&D budgets and the remaining internal R&D is more closely linked to the company's core strategy, which has changed since the financial crisis; innovation cycles have shortened, and the time-to-market has become more important, making it more difficult to pursue longer-term research projects. Basically, banks are looking for new ways to innovate in order to meet the demands for more incremental innovation projects and, at the same time, a more disruptive innovation environment (e.g., cryptocurrencies). This, however, is mainly driven by the fin-techs. Therefore, more agile innovation structures and cooperation with third parties and large technology companies such as Google and Microsoft or other Software companies like Tenemos, Avaloq have become more important, especially for smaller banks. Through collaborations often in a federated approach - including universities and associations - banks are looking for complementary skills that cannot be offered internally, partly compensating for the difficulties in hiring international talent, who is largely absorbed by large tech companies and also by dynamic fin-techs. Switzerland has a principle-based regulation which allows for innovation activities. However, it takes courage to use this space, not only from the companies subject to the law, but also from the supervisory authorities, such as FINMA and the self-regulatory organizations in the area of money laundering law.

2. Have the most important sources of knowledge and participants/ contributors to the design and realization of innovation projects changed?

Do SMEs work more with public/private, R&D/non-R&D, national/ international partners? Have collaborations changed to being more often bilateral/multilateral (e.g., in clusters, networks) or of low intensity/high intensity?

Given the dynamic digital environment, new skills and knowledge are needed, especially in data management, into which banks are trying to tap through collaboration. Partners are universities, start-ups

other banks or via associations. The latter are necessary to solve technical problems that a smaller bank cannot handle by itself. Thus, the banks increasingly need a functioning ecosystem and the government will then contribute significantly to this development. More and more, banks have investment funds for fin-techs in order to identify and possibly adopt new potentially successful technologies in time. They can then reduce their internal R&D investments while mitigating the development risks associated with new technologies. They also provide “sandboxes” in which fin-techs can test their business models. This strategy of risk reduction is often not open to the smaller banks, especially since a participation/acquisition in/of successful fin-techs is usually too expensive. Smaller banks have to bear the development risks alone. However, they are usually more flexible and can arrange for a collaboration at par with fin-techs allowing them to reduce their own investments. Overall, the start-up dynamic has increased, and the ecosystem is growing. However, there are at least two noteworthy trends: a) very large banks, but also companies like Google, are absorbing start-ups, and b) when fin-techs want to expand, they go abroad, especially to Germany, where the growth potential is higher due to the possibility of fast and effective scaling.

3. Have innovation projects changed in any way, e.g., with regard to their:

a) structural characteristics (e.g., size, duration), b) aims, c) proximity to the core business, d) approaches, e) tools, or f) likelihood of being successful?

In general, innovation activities in banks are more closely linked to information technologies. This increases their complexity and, combined with scarcer financial resources, leads to smaller innovation projects. However, this approach allows for rapid testing, learning and re-introduction (shorter trial-and-error loops). The pressure for more agile " speedboats" (e.g. credit card billing apps) has increased significantly, especially in the front-end of the business; this is where the innovation momentum is greatest. The back ends are traditionally stable. There is also a trend towards greater segmentation of the value chain. Fin-techs focus on individual parts of the value chain. This forces the banks to focus more on their core businesses. Universal banks that cover the entire value chain are progressively becoming part of a more diversified ecosystem. To remain successful in such a dynamic environment, a change in mentality towards more openness, partnership-based interdisciplinary thinking, collaboration with competitors (coopetition) and an "allowance for failure" is needed.

4. Has the frequency (or importance) changed of:

a) Innovating products (goods or services), b) innovating business processes (any function related to the production, distribution/logistics, supplies, IT systems, or development of new products and business processes), c) organisational innovations of administration and management of the firm (e.g., workplace organisation, external relations), d) marketing innovations (pricing and revenue models, promotion, packaging, product placement, or product design), e) any other type of innovation, e.g., to raise sustainability, reduce the climate footprint, or increase the social responsibility of business operations.

Yes, the frequency of all the above-mentioned innovation features has increased. The importance of interdisciplinary teams to develop of business models has increased and it would be important to involve financial lawyers in innovation projects at an early stage. However, it is difficult to develop a business model at the very beginning of a technological development. The business often has to be discovered. For example, a blockchain, bases its business model on transparency and fees paid for contracts. If this were not the case the business model could be related to digitised shares. There are opportunities for new start-ups here. In order to develop pioneering innovation as quickly as possible, so-called "sparring partnerships" between political authorities and the financial sector would be helpful. Regulation also plays an important role in the potential for innovation. The banking sector is highly regulated, which, as already mentioned, influences innovation dynamic.

5. What are the main reasons for these ongoing changes?

What consequences have firms experienced, for instance, with regard to productivity, revenues, cost structures, supply chains, market penetration, market extension or the like?

The increasing digitalisation of the banking and finance sector, the growing competition from fin-techs, regulation, the demand for sustainable products/services and demographic changes are among the key drivers of innovation behaviour and enable new business models with a strong technological component. Specifically, the use of artificial intelligence accelerates business processes and offers new opportunities for analytics and product development. Edge computing also leads to new business models and enables new partnerships. The increasing availability of public data (e.g., from the Federal Statistical Office), open-source software and more knowledge about agile processes facilitate innovation. In addition, regulations for APIs in the European payment system or more generally a “common API” could also drive future innovation. Currency and state sovereignty are important and that greater independence from international payment services (e.g., Visa and Mastercard) could trigger a surge in innovation, see, for example, the collaboration between Apple and Goldman Sachs. Clearly, such changes require a lot of investment and new skills, which puts pressure on some banks' profit margins.

6. What changes to innovation policies result from these dynamics?

Do we need new measures for supporting innovation activities more effectively?

Attractive framework conditions for innovation are very important and should be a priority for policy makers. This includes a stable infrastructure, fully digitalised communication (no more paperwork, e-government, or e-identity) and open, automated interfaces (APIs). This would open up new spaces for software development and innovation. Policymakers should generally promote a culture of innovation, testing and failure (sandbox principle). There is disagreement about the benefits of direct innovation funding. On the one hand, this instrument is considered unnecessary or unhelpful as funded inventions may not meet market demand. On the other hand, institutions such as the Singapore Fund are seen as a positive examples of innovation promotion in the financial sector. There is also no consensus on the need for a federal VC fund, but there is some agreement that there is a lack of financial resources for the scaling phase of fin-techs and a lack of real early-stage financing in Switzerland (in contrast to Silicon Valley, for example). In addition, the existing "round tables" are welcome, and more are desired to further develop the regulation of financial markets and to improve the flow of information between stakeholders on projects in the administrative area. A central contact point (one-stop-shop) for innovations should be established. The Federal Statistical Office or some other office could act as a kind of data hub, bringing together all the relevant cross sectoral information and issues (e.g., concerning data processing, DLT/blockchain, artificial intelligence). This would give banks/fin-techs access to develop better/innovative products. Data ownership is an important issue and there are international initiatives such as the German multi-bank initiative, which is currently being rolled out in Switzerland as well. Switzerland is rather slow when it comes to such issues due to its more market-driven approach, which challenges its competitiveness. In addition, the lack of access to the Horizon Europe programme is a problem in many ways for the financial sector, including the lack of available skills. Policy measures should specifically address the skills issue in Switzerland, for example, by making the country more attractive to international talent. Innovation means taking risks and often requires collaboration with other companies/institutions. That is why we need a protected space to discuss innovation. Associations would be the right place to do this. Intellectual property issues could be an obstacle to the development of functioning ecosystems. However, the problems of intellectual property can be tackled well if one works in a truly interdisciplinary way and includes not only the technical and economic aspects but also the legal side early enough.

Hearing 5 Food, retail

Participating experts:

40. Peter Braun, Swiss Food Research
41. Olga Dubey, Agrosustain
42. Christoph Hartmann, Nestlé
43. Marc Linzmajer, IRM - Institute of Retail Management, University of St. Gallen
44. Francesca Paganelli, Polygal AG
45. Vincent Vida, Upgrain
46. Fabian Wahl, Agroscope
47. Elias Welti, Handel Schweiz VSIG

Written input:

48. Urs Furrer, Biscosuisse
49. Martin Henck, Hilcona
50. Giovanni Nisato, Innovation-Horizons GmbH

Key questions of interest

1. Have innovation activities in SMEs changed in the last 15 years (since the financial crisis 2007-09)?

For instance, has the importance of research and development (R&D) activities changed? Has it become more common to adopt or imitate innovations introduced by others, e.g., global technology or industry leaders? Has the importance of obtaining external knowledge (through knowledge transfer) changed?

Innovation in the food industry has hardly changed. Companies look closely at what competitors are doing and try to copy that. Small, incremental innovations have always dominated. The focus is more short-term, tactical, and survival-oriented growth rather than on a strategic one.

Large companies continue to invest in R&D and engage in technology development. They can still afford mid-term to long term projects. Large companies can support own internal innovation, benefit from an internal ecosystem (including access to HR) at a world level. However, R&D returns have moved to the centre stage and R&D is expected to contribute to 'products on the shelf'. Product development is still important, but it is embedded in innovation pipelines fed by current trends such as changing consumer preferences (e.g., accommodating dietary restrictions) and megatrends such as sustainability or the reduction of the carbon footprint.

Among SMEs, the importance of R&D has grown which is illustrated by the appearance of various interest groups which focus on food R&D/innovation. At the same time, SMEs still struggle with finding internal resources for R&D. Sometimes they are unable to co-fund their part as required by Innosuisse. Still, SMEs need collaborations to deal with the growing complexity of food innovation and to obtain access to new food-technologies. Competence mixes and cooperation are becoming more and more important, especially for SMEs. Outsourcing long-term projects has also become more common.

In theory, Switzerland is ideal for innovation and start-up activities in food-tech. The big players like Bühler, Nestlé are already in the game and there is a high dynamic between them due to intense competition. Many students are interested in creating their own companies and a new generation of entrepreneurs is emerging. The number of dynamic start-ups has increased. The start-up economic system has strongly developed in food-tech as well as in agro-tech. More investors and VC funds have an interest in food sector start-ups. Large companies are also very interested in working with start-ups: they invite them to cooperate in order to share know-how and, in return, provide access to expensive

infrastructure. Still, start-ups often struggle with obtaining access to the competences necessary for making innovations successful.

2. Have the most important sources of knowledge and participants/contributors to the design and realization of innovation projects changed?

Do SMEs work more with public/private, R&D/non-R&D, national/international partners? Have collaborations changed to being more often bilateral/multilateral (e.g., in clusters, networks) or of low intensity/high intensity?

In general, the inclusion of external knowledge sources has become more important. More co-working and co-discovering is being done. The participants agreed that the increasing complexity of having to combine knowledge from different fields, the covering of a wider set of topics (from changing customer preferences to new digital and production technologies and more elaborate product safety and content requirements) also requires more collaboration in the food industry. Collaboration is especially important for large long-term projects. The innovation ecosystem has become more agile, is market-driven, and new players are coming into play (including new scientific service providers).

However, there was some disagreement regarding what this meant for the structure of partners. On the one hand, universities have become less attractive as cooperation partners due to the more incremental and short-term nature of innovation projects. On the other hand, the co-creation of knowledge with universities has become more important for start-ups which work more with academic partners (reasons: resources, e.g., expensive infrastructure).

Still, large companies tend to have an advantage compared to SMEs and start-ups when it comes to collaborating with universities for a number of reasons: 1) They cooperate with lots of universities and use different mechanisms, e.g., via the establishment of student teams within innovation projects and challenges, bilateral development projects, etc.; 2) they are better prepared to engage in discussions and negotiations concerning Intellectual Property Rights (IPR). SMEs and start-ups collaborate more with academia, even if it is difficult to find the right partners.

Several issues make collaboration between academia and companies more challenging. First, universities lack flexibility in the sense that they do not have the possibility to answer a request from a start-up quickly because of competing research tasks; likewise, universities of applied sciences (UASs) lack the resources because of too much teaching. Overall, universities do not have enough time for the innovation projects of small firms. Hence, short-term collaboration requests (e.g., with the ETHZ) might encounter the barrier of insufficient resources on the university side. The ETH used to be more closely networked with the Swiss food industry (SMEs). Today, cooperation has shifted more towards universities of applied sciences, as their research is more practice-oriented and they focus less on IP (see below). Second, universities are also interested in projects lasting 3-4 years because of their PhD students, whereas UASs are more interested in short-term projects like the companies (but lack the resources to implement them). Third, another problem is the access to IPR. IP-ownership discussions have become more common. Certain universities focus more on owning and protecting IP than others (e.g., UASs). Therefore, access for companies in joint projects differs. This can be harmful to start-ups because it is very important for them to own the IP. Because of increasingly complex negotiations regarding IP, bilateral collaborations are easier to implement than multilateral collaborations.

Some companies also find value in collaborating with foreign universities and research institutes (e.g., if the required knowledge and competencies are not available in the Swiss R&D system), but generally,in the food sector, the partners are geographically not very widely spread. One reason is that food preferences and the relevant legislation differ internationally. In addition, access to EU instruments has become more complicated, especially after 2014 and again more recently. Innosuisse co-funding has become more important.

Large firms like Nestlé are very interested in cooperating with start-ups, also at an early stage. Important partners for product innovations are start-ups. Strategic partnerships between companies and start-ups have also increased. A division of labour between the two company-types would have start-ups do the product development and larger corporations like Nestlé or Emmi would then market and distribute the products.

Development collaborations between companies benefit from identical time horizons and objectives/cultures. Companies therefore tend to collaborate with other companies whose know-how, machines or ingredients enable practical implementation. Projects in basic research and development are rather uncommon.

More innovations are produced with customers and partners. Involving customers in innovation projects is central in order to test different applications of a new product. In the food sector, innovation is more demand-driven due to changes in customer behaviour (5 years ago, 10% of the population followed a special diet, today 50%) and therefore the depth of innovation is higher. In apparel and electronics, on the other hand, innovation is more related to marketing and there is little customer involvement. A rather SME-specific issue in the food sector is often how to convince the retail trade buyers. Before it was all about the consumer and the product or the innovation. Regarding "free" innovation, this can have a restrictive effect.

3. Have innovation projects changed in any way?

e.g., with regard to their structural characteristics (e.g., size, duration), aims, proximity to the core business, approaches, tools, but also likelihood of being successful?

Bilateral projects are easier to implement than multilateral collaborations because of IPR issues and complex IP negotiations in multi-partner consortia. Larger consortia function if no IP is involved, e.g., on topics such as food safety or nutrition. Clusters help with networking, but there are not a lot of multilateral collaborative efforts in CH. They are rather low intensity efforts and often not vitally related to core business and innovation.

The increasing complexity of projects and knowledge fields required for successful innovations also creates challenges for collaborative innovation between companies and academia which is organized usually in disciplines and fields of research. Interdisciplinary research creates challenges for universities and UASs as well.

4. Has the frequency (or importance) changed of:

a) innovating products (goods or services), b) innovating business processes (any function related to the production, distribution/logistics, supplies, IT systems, or development of new products and business processes), c) organisational innovations of administration and management of the firm (e.g., workplace organisation, external relations), d) marketing innovations (pricing and revenue models, promotion, packaging, product placement, or product design), e) any other type of innovation, e.g., to raise sustainability, reduce the climate footprint, or increase the social responsibility of business operations.

Radical innovation, the development and introduction of completely new processes and products, has declined in the food industry over the last few years. *Incremental innovation*, efforts to adapt products, recipes, ingredients, etc., has grown for a number of reasons: a) Retailers constantly want new variants and varieties on the shelves, which are quickly discarded if they are not successful. The products are becoming more short-lived and the time horizons of innovation projects in companies have correspondingly become shorter than in the past. b) Recipe adaptations are an ongoing issue, regarding sugar reduction requirements, substitution of raw materials (undesirable ones like palm oil or unavailable ones like sunflower oil), production costs, labels, etc. c) The cost pressure is increasing and this is a great

challenge for product development departments. Against this background, the product development departments are now less concerned with "actual" innovations and more with adjustments to existing ones. The focus on incremental adjustments also reduces the available resources for "real" innovations. With such an approach, Swiss companies are followers, not front runners.

Regarding the content of innovation, it can be said:

a. Product innovations remain very important. The share of products with new technologies has strongly increased in individual product segments (e.g., plant-based). Technology-based innovations which draw on new technological opportunities (e.g., from wet extrusion or precision fermentation) have increased as well.

b. Innovations in processes (keyword digitalisation) have also become more important. IT, logistics, demand planning are application areas for the new technologies. The food industry is strongly efficiency-oriented due to low margins. The increasing shortage of labour is accelerating technological innovations. Access to high quality IT and digital marketing services is also an opportunity for companies that have unique value propositions in order to identify and engage customers worldwide; with the required appropriate budgets and skill sets, digital marketing and market intelligence provides for more level playing fields. As digital innovations require access to cost effective and high quality (bandwidth) infrastructures, SMEs in rural cantons and regions might be relatively penalized.

c. In the area of organisation, flexibility and efficiency are in the foreground. Here, too, we see new approaches to efficiently manage the increasing complexity. COVID has provided an opportunity for many companies (large and SMEs) to re-evaluate remote and flexible working options. A beginning of culture change may be visible.

d. Major upheavals are also underway in marketing, especially in the areas of communication and brand building. Marketing has also changed due to the introduction of new business models (e.g., B2C), which have had a direct impact on service and product offerings. Data-driven business models are on the rise. Marketing, social media and the influence of young, media-savvy consumers can influence and inspire innovations (e.g., sustainable packaging). On the other hand, a consumer’s quick and superficial assessment of a product in social media can be seen as an innovation-inhibiting factor. Potential points of attack for the product and the manufacturing company must be constantly considered.

e. There are new business models along the food industry value chain. However, it is difficult to provide digital services along these them, more so than in other sectors. Service innovations are generally more difficult to implement in the food sector.

f. The importance of sustainability-oriented innovations is described under question 5. Further innovations are to be expected here in order to achieve the goals of climate-neutral business activity. The current raw material and energy prices are some of the conditions necessary for a sustainable business model.

5. What are the main reasons for these ongoing changes?

What consequences have firms experienced, for instance, with regard to productivity, revenues, cost structures, supply chains, market penetration, market extension or the like?

The key determinants of innovation activities in the food sector are the following:

- *New consumption trends*, such as vegetarian/vegan foods, special foods, plant-based products, lactose-free products, focus on nutritional value and healthy food, or focus on the product origin, partially nurtured by global travel. Globalisation has made the requirements for successful food innovation more complex. In the past, price and taste were the decisive parameters. Today, nutritional values, sustainability, etc. have been added.

- *New technological trends* (e.g., wet extrusion, precision fermentation, cultured food, health ingredients) have been triggered by large investments in research, especially in the USA but also in Europe. Swiss companies in the food industry have to develop strategies on how technological developments can be implemented to become enablers for more efficiency, new products, services or business models. This means that they increasingly have to complement their core businesses with new technological expertise, which is a major challenge but also creates new opportunities. Networking and cross-sectoral cooperation (e.g., IT, bio-tech, 3D printing) are therefore becoming increasingly important. SMEs must focus on fundamental innovation or concentrate on market-ready technologies (e.g., through cooperation). The application of existing technologies in another sector enables new offers and differentiation opportunities.
- *Megatrends*, e.g., sustainability, climate change, reducing global hunger, reducing waste (e.g., for packaging) cannot be ignored in innovations. The topics of nutrition and sustainability must be a part of practically every innovation in the food sector today, whereas, in the past, the focus was more on the product itself. Bio and Eco sustainable products and services have entered the mainstream. Metrics on carbon footprint (or CO2 saved) have become part of the communication to consumers. Discussions on B2B ecosystems for the circular economy are emerging.
- *Regulations and labels*, e.g., regarding food safety, product origin, or packaging, may stifle the speed of innovation. Quality management has become more complex due to the increased regulatory requirements. The pressure for innovation is high (sustainability, food trends, hunger, etc.). However, regulation cannot react as quickly as it should. On the other hand, in view of the manufacturers' responsibility for the safety of their products, regulations can also relieve some of the burden, especially for SMEs with fewer resources, provided that the manufacturer does not have to assess every risk.
- *Political framework conditions and international market access* also exert a strong influence on the Swiss food industry. The appreciation of the CHF towards the Euro and (less so) towards the US$ has created challenges and opportunities for companies, especially SMEs, depending on their positions in the international value chains and their profit margins. Operations with subcritical-mass unable to compete nationally and internationally fail; they seek innovation as a late survival tactic but cannot implement it. Players in good positions can fall into complacency, making them vulnerable to new (outside) competitors.

6. What changes to innovation policies result from these dynamics?

Do we need new measures for supporting innovation activities more effectively?

A wide scope of suggestions was made concerning innovation policy issues. Of a more fundamental nature are suggestions to add some directionality to innovation policies and include specific support for sustainable food, similar to other areas where sustainability is politically promoted (e.g., energy). Additionally, there was general agreement that the knowledge and potential of academic institutions – universities, UASs, and research and technology organizations (like CSEM, inspire, Agroscope etc.) – are underused for innovation in the food sector and that their long-term perspective and priorities are often not in line with the short-term perspectives of companies. Hence, if this cannot be overcome by more Innovation boosters and initiatives to bring academia and companies together (which would be desirable) it should become an option to directly subsidize innovative SME clusters and corporate innovation activities. This would make longer R&D-based innovation more attractive (reduces risk, frees resources, etc.) and counterbalance the pressure from customers to focus on fast, incremental innovations. Furthermore, regarding the support to start-ups, more follow-up funding to Innosuisse projects (the phase from invention to innovation), more specialized and pilot laboratories along with workbenches are needed. More support from public innovation funding for market entry and help with finding contacts with and timely feedback form regulatory authorities could also be added. Complexity in innovations is a challenge which has to be overcome. Lastly, on an operational level, it was stated that processes in public innovation funding should be accelerated. Cooperations between start-ups and universities are hampered by long processes. Waiting two months or more for the approval of a project is prohibitive

because of the running costs and the pressure from customers. On the other hand, it was suggested to add KPIs to sustainability issues and compliance with SDGs in approval processes (which could make approval processes of innovation projects even more complex). Innovation cheques are not very attractive because there is not enough funding to hire the necessary people.

Hearing 6: Energy, retail, construction and cleantech

Participating experts:

51. Martin Heuschkel, Infors HAT
52. Beatrice Schaffner, Schaffner Smart Solutions AG
53. Birgitta Schock, schockguyan partner gmbh
54. Franck Schürch, Energie cluster
55. Martin Naëf, ABB
56. Christophe Baillif, CSEM
57. Marcus Baeckmann, 3S Solar-plus
58. Derk Baetzner, Meyer Burger Research

Written input:
59. Eric Plan, CleantechAlps

Key Questions

1. Have innovation activities in SMEs changed in the last 15 years (since the financial crisis 2007-09)?

For instance, has the importance of research and development (R&D) activities changed? Has it become more common to adopt or imitate innovations introduced by others, e.g., global technology or industry leaders? Has the importance of obtaining external knowledge (through knowledge transfer) changed?

A - Fewer companies do R&D. What I see is a decrease in the R&D of middle-tier companies. Firms innovate if there is a pressure.

"If I look my company, ABB (and other big companies) has not fundamentally changed."

In relation with the financial crisis in late 2000, firms – SMEs – put the emphasis on optimization (process & product). Today, the optimization potential is less on the focus (has been largely exploited by innovative companies, there is still potential for others) – the question is how to bring these companies on board.

B - External knowledge is now more important than before. There is also more external knowledge to acquire. There is more cooperation between academia and the private sector. The digital journey is very important.

It is now more complicated to work with the universities: they want to commercialize their IPs.

Today with AI, the use of data is at the beginning of its development and Swiss companies should not miss this. (the ETHZ and IDIAP/EPFL/Energypolis are at the forefront of this topic).

Networking with other firms and contacts with local authorities are very important success factors.

CSEM has a lot of requests from firms for collaborations. These collaborations are long-term because a lot of time is needed to have a new product in the energy sector.

C - Venture capital in Switzerland is good – supporting very active start-ups – but not enough to finance the scaling phase. The start-ups do not have the skills to manage R&D. Larger companies invest more in start-ups – making the start-up ecosystem more complete.

D - In the meantime, digital technologies have achieved maturity to foster innovation. Whereas innovation was mainly concentrated on IoT based tech/app during the past 10 years, it has generated a lot of data. A great deal of innovation-based data is coming up.

Innovating firms like the start-up Smarthelio is at the edge of innovation and is leading the way for other start-ups and SMEs: making big data driven predictions to support the operation and maintenance activities. Both are promising future businesses for the energy sector (but not only).

2. Have the most important sources of knowledge and participants/ contributors to the design and realization of innovation projects changed?

Do SMEs work more with public/private, R&D/non-R&D, national/ international partners? Have collaborations changed to being more often bilateral/multilateral (e.g., in clusters, networks) or of low intensity/high intensity?

A - Much more collaboration between SMEs and the universities. It is easier to collaborate with the UASs. With the ETH domain: larger projects, not as easy. SMEs cooperate with high education institutions but if they want to go fast they cooperate with other companies. They speak the same language and are facing the same time frame (academic timing is different than industrial timing). SMEs have difficulties setting up long term development as the market is always evolving faster requesting fast adaptation.

We have observed an evolution from an academic-centered approach to a more cross-industry or inter-firm approach. The idea that innovation comes from academia is still strong but enterprises, mainly SMEs, also increased their collaboration with other companies. This directly impacts the way new products/services are designed.

B - Understanding behavioural and social practices is becoming key for innovating firms to make their business models evolve. Closer collaborations with universities (UNIGE, UNIL, ZHAW, HES-SO (living labs)) have to be fostered. Ideas here include student internships in companies.

This last point leads to the fact that know-how transfer has to move to TT4.0:

- Inclusion of expertise in the companies in a hybrid public/private system,
- Organize know how transfer in a tailor-made approach: small scale instead of seminars such as within PNR programs (based on PNR 70/71 and 73 experience)
-

3. Have innovation projects changed in any way, e.g., with regard to their:

a) structural characteristics (e.g., size, duration), b) aims, c) proximity to the core business, d) approaches, e) tools, or f) likelihood of being successful?

A - We have to speed up the processes for the innovation projects. The important question for a SME is how to go faster to the market? Precision, scaling up and speed are important. This requires automation. Expensive investments and long-term plans

B - The role of the customer is increasing.

C - The internationalization of suppliers is increasing and this causes some problems to obtain an Innosuisse project.

D - The vast majority of innovation is incremental. It does not mean that disruptive innovations are not important, but they are very rare.

E - There is now a real research portfolio in the SMEs which corresponds to the network of the company and both co-evolve.

F - Networking is important because different competences are needed for an innovation and no one firm can have all of them.

G - The diversity of project size and its duration is bigger. In the cleantech sector (energy, environment, mobility/transport) the trends are towards bigger (more expensive) projects as the duration is more based on the increasing hardware part (infrastructure).

4. Has the frequency (or importance) changed of:

a) Innovating products (goods or services), b) innovating business processes (any function related to the production, distribution/logistics, supplies, IT systems, or development of new products and business processes), c) organisational innovations of administration and management of the firm (e.g., workplace organisation, external relations), d) marketing innovations (pricing and revenue models, promotion, packaging, product placement, or product design), e) any other type of innovation, e.g., to raise sustainability, reduce the climate footprint, or increase the social responsibility of business operations.

A – There is no consensus here about business model innovations (BMI): BMI ideas are lacking (notably on new pricing and revenue models). BMI is much more frequent.

The change in BM is speeding up but a lot of development is still needed; firms have to adapt/change their BM. There is no choice.

B - Sustainability requirements have massively increased. It is becoming a real business model. It is not just a marketing innovation. Systematic integration of CO2 impact (carbon-offset based BM, CO2 valuation) is still in progress. There is a lack of transparency and long-term vision e.g., a lack of understanding of the challenges and the impact for SMEs.

Social innovations are still behind in terms of behavior, understanding, and integration in the design of new services/products: there is room for improvement at all levels.

C - Organizational innovation: the hierarchies are flatter; it creates incentives for more innovation regarding a firm's administration and management (workplace, organization, external relations). Also, there are more marketing innovations: promotion, packaging, product placement, product design.

D - Products

Services innovations are increasingly due to /thanks to digital technologies – circular economy, apps, economy of functionality.

E - Processes

Same here: the innovations in the area of distribution, logistics (material sourcing and even human resources sourcing) are highly impacted by ICT/digitalisation.

5. What are the main reasons for these ongoing changes?

What consequences have firms experienced, for instance, with regard to productivity, revenues, cost structures, supply chains, market penetration, market extension or the like?

A - The competitive environment is changing as digital, sustainability and social (behavior) aspects have to be integrated. Multi-partner collaborations are compulsory. Emerging demand for a product redesign with local material, including recycled material.

High innovation potential on new/recycled materials and material certification

B - Energy market liberalization has stimulated BMI

C - Impact of Covid and the Ukraine war has effect at different stages. Supply of resources (including human), cost uncertainty due to price volatility, logistics and crossborder restrictions, are unstable and

fast changing. All these factors have an impact on changing the focus towards local supply chains and local resources.

6. What changes to innovation policies result from these dynamics?

Do we need new measures for supporting innovation activities more effectively?

A - Not clear consensus on the current role and effect of Innosuisse: The support from Innosuisse has increased. A lot of paper processing, administrative work is required by Innosuisse.

Model of support involving 40 % of the funding coming from a company is a good model.

The Innosuisse model of support does not fit in with the mindset of the entrepreneurs. Projects support need to be differently designed to match how firms are operating. Firms use a much more trial and error logic and go fast to the client

B - Start-ups would like more loans (for 10 years) to ensure they have enough time to mature their new technology. More funding from Innosuisse would be welcomed.

VCs are interested in start-ups that can achieve scale to address high growth markets and provide large pay offs within a short time period. However, energy start-ups don't match very well with such a model: the willingness to pay for clean energy is not obvious; investments feature long time horizons, they are capital intensive; large companies in the energy sector are less active in acquiring start-ups (no exit option) as compared to their counterparts in pharma. Also, in the energy domain, innovation is just a first step – integration is key because of the existing infrastructures.

Thus, VCs have limited impact and other financial mechanisms are needed.

C – We need more instruments to engage SMEs/industries in the AI. Companies need to have access to anonymized real data. Innovation instrument at national level could support this (biomass, electricity, etc.)

In some critical areas, we need larger SNF projects.

Direct subsidies to firms should be made possible in Switzerland – (we are now competitively disadvantaged vis a vis other countries)

Financing instruments should cover certification (new/recycled materials).

Financing instruments are missing down the value chain to industrialization (or current instruments have too restrictive eligibility criteria – they could be easily adapted if not anchored in the law).

Innovation loans (Innovationsdarlehen).

Many innovations appear, but the business case has not yet demonstrated. They can't be supported with the existing instruments – perhaps a role for the UASs.

D - Innovation policy requires an environment policy (to get all prices right so that clean tech and clean energy are not disadvantaged vis a vis dirty energy).

E – There is an important lack of skilled manpower in SMEs and down the value chain for product technology provision in the energy sector. It is important to keep the best people (PhDs, postdocs, talents) and attract talent from abroad. Innovation is needed to define and restructure current educational stream (formation and post formation).