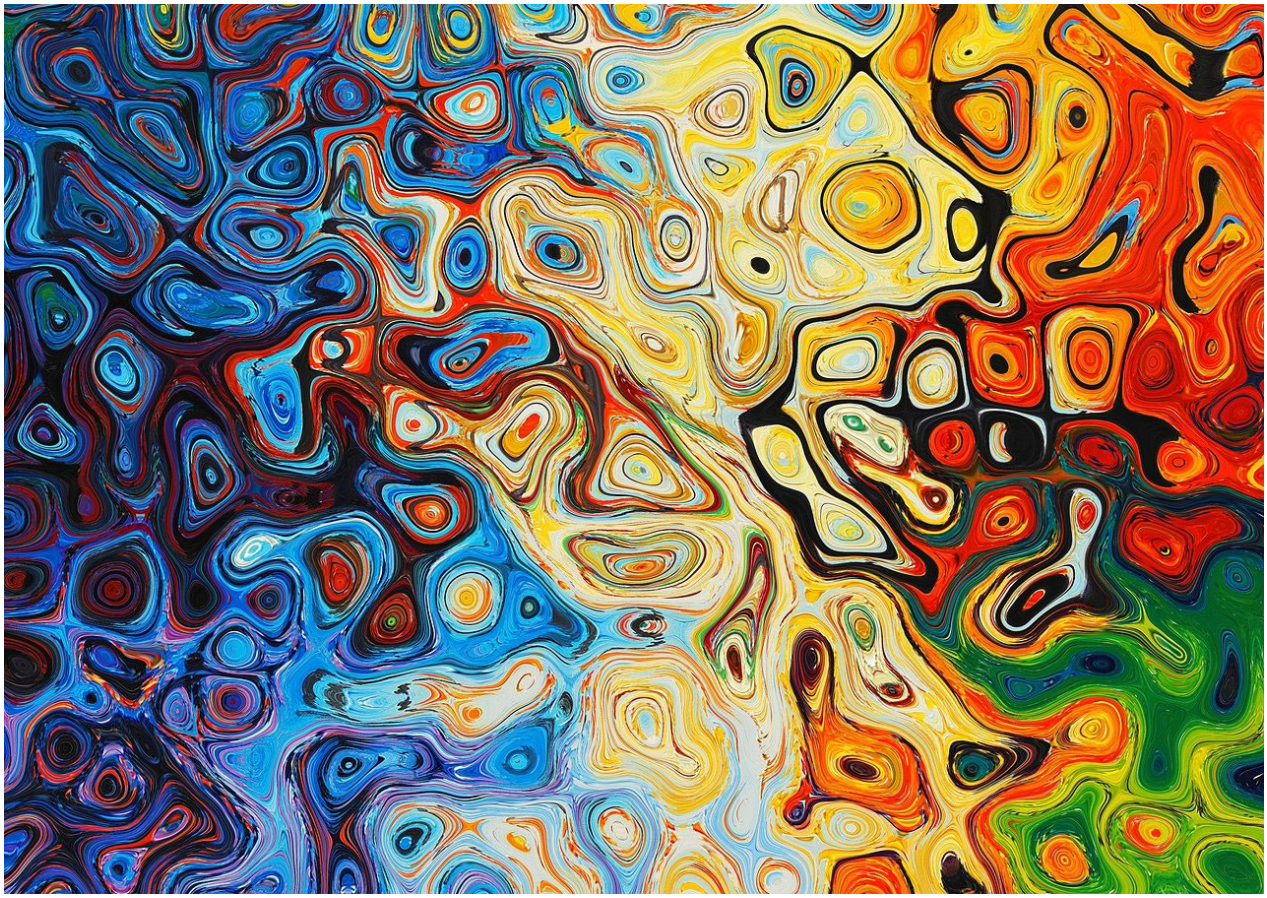
Full proposal “New innovation models” – public document



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1 Project background and field of research

Switzerland is one of the most competitive countries in the world. Commercially successful innovation activities are an essential part of this achievement. However, for some years innovation statistics show a significant decline in the fraction of research and development (R&D) active companies in Switzerland. This overall decline is mainly due to developments among small and medium enterprises (SMEs), and it raises several questions that should be addressed in this project.

In autumn 2022, the State Secretariat for Education, Research and Innovation SERI commissioned a first short study to analyse the decline in R&D-performing companies and trends in the innovation activity of Swiss companies by means of six hearings with representatives from industry sectors. This study revealed several factors that pose major challenges to companies' innovation activities.[1] These include, above all:

1. Growing centricity of consumers and generally clients in processes of innovation,
2. Widespread digitalisation of innovative products and services,
3. Marked demands for considering sustainability in innovation projects,
4. Increasing influence of regulations,
5. Transformation of the competitive environment (e.g., geographically, new entrants from technology industries, disruptive start-ups, etc.).

Most importantly the first study made clear that the conditions and contexts of innovation are to some degree sector-specific, and a “one-size-fits-all” approach is neither suitable to understanding corporate innovation activities nor from a policy perspective appropriate to support them. Hence, this second project is dedicated to new sectoral innovation models and their consequences for innovation policies. Against this background, three key areas of adjustment were defined to better understand the new innovation models, identify potential weaknesses in the current (regulatory) policy framework and, if necessary, propose recommendations for Swiss innovation policy: 1) Data-related practices and needs in corporate innovation activities, 2) sustainability-related innovation activities and drivers and bottlenecks of such innovations, and 3) collaboration practices and needs.

The project is in the field of innovation studies with a strong focus on innovation economics, innovation management, and innovation policy. More than 60 years ago innovation economists have suggested the existence of knowledge spillovers from R&D that are not compensated by the market, which means that the results of R&D not only benefit the investing companies but also, among others, their competitors (Arrow, 1962; Nelson, 1959). Moreover, investments into basic research may require considerable time to generate commercially exploitable results, and in the worst case these might not materialize at all, i.e. the outcome of R&D is uncertain (Aghion, David & Foray, 2009). These characteristics of R&D and above all basic research generate negative incentives for private R&D investments, constituting different types of market failures which reduce private R&D investments below the socially optimal level. This underinvestment in R&D by the private sector has been for many decades the main justification for public innovation policy, above all in the form of public R&D investments. Furthermore, the work on "absorptive capacity" found that companies are better able to absorb and utilise external knowledge the more in-house knowledge they have (Cohen & Levinthal, 1990). This absorptive capacity grows, as companies learn, among other things as a by-product of R&D activities. Expenditures for R&D activities have therefore been a key metric to assess and judge firms’ innovation efforts for many years. Nevertheless, other activities, such as engineering, design, marketing, employee training, or software development, have also been suggested as relevant for generating innovations (OECD & Eurostat, 2018). Depending on the key activities, a distinction between a Science, Technology, and

[1] See Barjak, Foray & Wörter (2023) on the results in more detail.

Innovation (STI) mode of learning and innovation and a Doing, Using, and Interacting (DUI) mode has been suggested (Jensen et al., 2007). From the Swiss innovation surveys, we know that only approximately 40% of the product and process innovators conduct R&D and 60% do not, and the importance of the latter group has rather grown in recent years (Spescha & Wörter, 2022). However, R&D innovators overall tend to generate more innovations than non-R&D innovators – suggesting that the success rate of R&D-based innovation projects might be higher than that of projects not using any R&D – and the share of non-R&D innovations has been estimated at 11-12% of all product and process innovations in the US (Lee & Walsh, 2016).

Innovation management has been defined as “all systematic activities to plan, govern and control internal and external resources for innovation” and it has also been conceptualized as one of the non-R&D activities of relevance to corporate innovations (OECD & Eurostat, 2018, p. 91). The specialist literature on innovation management has indeed researched numerous internal and external influences on innovation success (Tidd & Bessant, 2018; Tidd & Thuriaux-Alemán, 2016): widely debated elements of innovation management are the strategic analysis and planning of innovation activities, the definition of responsibilities and processes for innovations, the generation or provision of innovation ideas and innovation-relevant data, or the development of a corporate culture that values innovation and change positively. The question of how innovation inputs from outside can be optimally identified and integrated or how internal innovation ideas can be commercialised externally has also been discussed in detail for many years under the heading of innovation cooperation and open innovation (Chesbrough, 2003). At the same time, economic innovation research has only been moderately successful with regard to measuring the impact of innovation management practices on innovation success: innovation management audit systems have been developed (Chiesa et al., 1996), but above all the more recent shift to open models of innovation, growing importance of services, and the digitization of processes and digital transformation of companies have fundamentally changed the conditions of success in innovation management (Frishammar et al., 2019). For Swiss companies, for example, only fragmentary data on innovation management practices is available.

These changes in recent years in the use of R&D for innovation and in innovation management go hand in hand with a changing target vector of innovation policy (Schot & Steinmueller, 2018): while from the middle of the last century until the 1980s, the goal was primarily to strengthen economic growth and compensate market failures, from 1985-2008 the focus of innovation policy was also on increasing competitiveness and resolving system failures, e.g., by developing networks and increasing the linkages between players in innovation systems (Lundvall & Borrás, 2005; Woolthuis et al., 2005). Since then, an additional focus has increasingly emerged in innovation policy, which includes the transformation and further development of economic systems in the direction of sustainability, conservation of natural resources, establishment of circular processes, etc. (Schot & Steinmueller, 2018; Weber & Rohracher, 2012). The meaning and implications of this paradigm shift for Swiss innovation policy still needs to be fully understood.

The project hence focuses on the four themes of data, sustainability, collaboration, and regulation in innovation. It analyses the current situation in selected sectors from the perspectives of innovation economics, innovation management and innovation policy. It will be conducted by three Swiss organisations with widespread experiences with economic policy-related analyses and excellent knowledge of the Swiss research and innovation system: University of St. Gall (B. Cornet, prof. em. EPFL D. Foray), ETH Zürich, KOF Swiss Economic Institute (M. Wörter) and FHNW School of Business (F. Barjak). A steering board made up of representatives of the institutions funding the study will accompany the project and secure close linkages to both, industry and public innovation policy, in Switzerland.

1.1 Research questions

The project wants to answer research questions, involve industry experts and policy-makers in the Federation and cantons, and generate recommendations in the three areas specified above. Above all the research will address the following questions:

1. *Data-related practices and needs in corporate innovation activities:*
   What type of data do companies use/need most for innovations?
   What data is generated internally, what is obtained from external sources, and what is being missed?
   What are the barriers to using more data?
   How has data affected innovations of products, processes and business models?
   How do "big data", AI, and other digital technologies help or hinder innovations?
2. *Sustainability-related innovation activities and drivers and bottlenecks of such innovations:*
   How frequent are sustainability-related innovations?
   What activities and processes are used to create sustainability innovations?
   How important is R&D and how important are other innovation activities for sustainable innovation?
   What triggers and what blocks them, and how are business models affected by sustainability innovations?
3. *Collaboration practices and needs:*
   What benefits or added value do innovation collaborations generate?
   What collaboration/ecosystem constellations drive innovation success?
   Which channels of knowledge transfer between, e.g., universities and companies are functional?
   How do firms evaluate the existing support measures to different forms of innovation collaborations (e.g., bilateral, multilateral)?
4. *Regulation:*
   Is the timing of regulations adequate? Are areas relevant for innovation overregulated? Where are regulations missing?
   What type of regulations, e.g. related to the environment, health, products, work or knowledge and Intellectual Property, affect corporate innovation activities?
   Which levels of government are responsible for the most influential regulations?
   How do regulations influence corporate innovation activities? What activities and strategies do companies use to comply with the regulations?

2 Approach and methods

2.1 Sectors and industries

Core sectors

The project focuses on four sectors and thus enables in-depth and more specific analyses that are not yet possible on the basis of innovation surveys of the entire Swiss economy:

1) Medical technologies (med-tech)
2) Finance & fintech
3) Pharmaceuticals
4) Information and communication technologies

The four sectors are remarkable with regard to their innovation dynamics according to the hearings and results of the first study. They are subject to a high commonness of new/non-R&D innovation models and a particularly pronounced impact of recent macro trends

(digitalisation, sustainability transition, supply/sales market disruptions). They are also particularly dynamic and important for Switzerland.

Ad 1) Medical technologies. In the med-tech industry R&D and innovation are of high importance (Swiss Medtech, 2022, 2020, 2018): 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). Our first study showed that the med-tech industry is subject to two main trends and long-term changes which have affected the innovation models and the importance of R&D in generating innovations in Switzerland (Barjak, Foray, & Wörter, 2023):

- *Regulations* above all at the European level, but in some cases also on the global or the national level 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.
- *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. New players have emerged as well in research and in supporting functions (e.g., intermediaries, incubators, brokers etc.).

As a consequence of these two trends smaller and mid-sized med-tech companies had to change their innovation activities:

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 collaboration and generally innovation-related collaboration 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.

Ad 2) Finance and fintech. Our own first study and other recent reports on the Swiss finance sector stress several trends which drive the innovation activities in the sector (Barjak, Foray & Wörter, 2023; Federal Council, 2022; Swiss Bankers Association, 2023). First and foremost, the growing performance and societal use of digital technologies and resulting

digitalisation of financial products and processes, connected to the market entry of new players, start-ups as well as large technology providers, in the finance sector drive innovation behaviour and enable new business models with a strong technological component. For instance, 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, and increase competition.

Banks have presumably reacted with cuts of their R&D budgets and the remaining internal R&D has been connected more closely to the companies' core strategies (Barjak, Foray & Wörter, 2023). Moreover, innovation cycles seem to have shortened, and time-to-market has become more important, making it more difficult to pursue longer-term research projects. According to industry experts, the close linkages of financial innovations to information technologies have increased their complexity and, combined with scarcer financial resources, resulted in smaller innovation projects (Barjak, Foray & Wörter, 2023). 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.

Attractive framework conditions for innovation are very important and should be a priority for policy makers according to experts from the banking sector (Barjak, Foray & Wörter, 2023). This includes a stable infrastructure, fully digitalised communication and open, automated interfaces (APIs). This would open up new spaces for software development and innovation. A data hub is needed, bringing together all the relevant and particularly cross sectoral information and issues (e.g., concerning data processing, distributed ledger technologies/blockchain, artificial intelligence) and giving banks/fin-techs access to develop better/innovative products. Last but not least, a growing demand for sustainable finance products by Swiss consumers was noted (Barjak, Foray & Wörter, 2023).

Several of these issues have been taken up by the Swiss Federal Council and the State Secretariat for International Finance SIF in the report "Digital finance: areas of action 2022+" (Federal Council, 2022) which has formulated an action plan to expand open finance, understood as the exchange of financial data over standardised and secure interfaces at the request of clients; to support data use and sharing in the financial sector; to support the use of AI and development of green fin-tech; or to strengthen the innovation potential of the financial sector in the long term by means of an innovation platform, among other action points.

Ad 3) *Pharmaceutical industry*. The pharmaceutical industry is one of the industrial backbones of Switzerland, with Roche and Novartis belonging to the top-50 companies of global R&D investors (Roche at rank 9 and Novartis at 17 in 2023) (Nindl et al., 2023). The sector conducts significant own research and draws on academic research for generating innovations, as many studies have shown (see the illustrative examples of Fisch, 2023, for Switzerland).

Ad 4) Information and communication technologies (hard- and software). As the discussions on the previous sectors have shown, ICT are closely linked to many of the changes which other industries currently experience as they constitute general-purpose technologies (Barjak, Foray & Wörter, 2023). ICT provides the hard- and software that is necessary for digitalising products and processes, for collecting, processing, sharing, and analysing data, and much more. ICT companies have the skills and technologies for innovative digital offerings in financial markets, healthcare markets and energy markets among others.

However, ICT not only drives and enables innovation in other industries, but it is also the subject of constant innovation itself. For instance, two widely discussed topics that require innovation are a) cybersecurity and achieving resilience to cyberattacks and b) the sustainability of ICT products and services in terms of the materials used and energy requirements (Perrelet, Spizzo, & Dibbern, 2023; Thomson, 2023). The most recent Swiss Software Industry Survey (SSIS) 2023 put a spotlight on sustainability in Swiss software companies (Perrelet, Spizzo, & Dibbern, 2023). It found that sustainability is considered as a topic with opportunities and strategic potential which influences the planning and design of software (through

use of the open standards of data formats and programming languages), the development of software (through reuse of code, continuous testing and integration, and standardization), or the maintenance of software (through extending its lifetime) (ibid.). However, it also obtained the result that sustainability matters rather little with regard to innovation capabilities and, above all, that sustainability-related R&D and management capabilities are not very well developed in the companies. According to the latest and previous SSIS reports, R&D investments in software companies fell from more than 14% of total revenue in 2014 to merely 3.4% in 2021 and then rebounded to 5.9% in 2022 (Perrelet, Spizzo, & Dibbern, 2023; Huber, Hurni, & Dibbern, 2015). Sustainability is also an important driver of change in the telecommunications sector, for example in connection with the use of Internet of Things technologies (asut, 2023).

The need for new innovation paradigms stressing the role of collaboration in order to successfully position Swiss ICT companies in their target market has been highlighted by blog contributions of the "Innovation" working group of swissICT under the headline of open innovation (Isenegger, 2022).

Supplementary sectors

In addition to the core sectors, the study will include samples from two further sectors to ensure a good representation of the Swiss economy as a whole. The two supplementary sectors will be the metals, electronics and machine (MEM) industries (NOGA 24-27, 261-268) and the food industries (NOGA 10-12). They contributed in 2021 8% (MEM) and 3% (food) to gross value added of the Swiss economy (according to FSO's value added statistics which excludes banking and insurance, https://www.bfs.admin.ch/bfs/en/home/statistics/industry-services/value-added-statistics.assetdetail.27405318.html). These two supplementary sectors will be included in the survey as part of Task 7 "Generalisation work", but no sector-specific questions will be asked, and no-sector specific analyses will be conducted.

2.2 Research design

The project pursues a multi-method approach and engages in three different methods which will be described subsequently:

1) Analysis of the literature and existing data sets on innovation in Switzerland
2) Survey of business enterprises, above all SMEs, in the included sectors
3) Delphi interviews and workshops with industry representatives.

Ad 1) Analysis of the literature and existing data sets on innovation in Switzerland. Drawing on the relevant academic literature and reports, e.g. from industry and professional associations, chambers of commerce, consultancies, we will describe the current knowledge on innovation models in each sector and how they have changed in the more recent past. Existing data sets on innovations and related activities in Switzerland, above all the Swiss Innovation Surveys from the Swiss Economic Institute KOF, will also be used to produce a state-of-the-art picture on sectoral innovation activities.

Ad 2) Survey of business enterprises. The main data source of the project will be surveys of samples of companies from the included sectors.

Sampling: A sample of companies will be drawn from FSO's BUR (Betriebs- und Unternehmensregister). The sample will be stratified by sector and enterprise size to ensure a proper representation of the firm population in each sector. The target response rate is in the range of 20%. FSO does not provide email addresses nor contact persons in the BUR address data and this information will have to be searched for and added manually by the project team. Further companies, e.g., members of participating associations, might be added depending on the preferences of the participating organizations and availability of address data.

Questionnaire design: The questionnaire serves two main purposes: 1) Understanding better the conditions and mechanisms of new innovation models, and 2) piloting of survey questions which may be used later in more comprehensive surveys, such as the KOF Swiss Innovation Survey.

It will include qualitative and quantitative questions, i.e. questions asking for attributes, behaviour and opinions in a qualitative manner (e.g., to illustrate with an example “Please answer how much each of the following barriers to using data affected your use of data for innovation activities” followed by a list of items with a Likert response scale). It will also use quantitative questions to collect, for instance, expenditures on research and development (R&D) and other innovation activities.

The questionnaire will consist of a mix of industry-specific and generic question modules to capture industry-specific issues and allow for some comparisons across industries at the same time. The advantage of such a survey would be (a) that new question formats can be tested without burdening all sectors and companies; (b) highly dynamic or sector-specific innovation paths can be explored; (c) it provides an important basis for follow-up work by industry associations and innovation policy-makers.

Questionnaire content will be discussed with the steering group of stakeholders. In addition, pre-tests with selected companies from the sample will be conducted a) by means of think-aloud interviews (respondents fill in the questions during a meeting in which they will talk about their understanding of the questions) and b) through an online pre-test with 5% of the sample companies. The questionnaire will be developed in German and French and the need to produce English and Italian translations will be evaluated during the pre-test phase.

Survey mode: For cost reasons the survey will only be conducted as an online survey. To guarantee an acceptable response rate up to two reminders will be sent out by email and phone calls will be used to approach all non-respondents of the survey.

Data analysis: In addition to tabular and graphical representations of univariate and bivariate statistics the project will conduct econometric estimations (multiple regressions) to identify the relevance of issues related to data, sustainability, regulation and collaboration for the innovation performance and understand relevant factors to reduce complexity and increase innovation performance. The regression models will be chosen and specified according to variable scales and underlying relationships between variables.

Ad 3) *Delphi method.* The Delphi method is a systematic, multi-stage interview procedure with an identification of agreements and disagreements among the participants and several iterations to find agreement and closure. It will serve to …

- identify the critical factors that relate to data, sustainability, regulation and collaboration in innovation activities,
- add practical expertise and experience to the interpretation of the survey data,
- develop ideas and find consensus about policy measures.

We will invite 6-15 industry experts in each sector to conduct Delphi method interviews and discussions.

3 Project consortium

The project is carried out by Martin Wörter (ETH-Zürich, KOF Swiss Economic Institute), Dominique Foray (prof. em. EPFL), Franz Barjak (FHNW) & Benoit Cornet (HSFG, CFAC). Whereas FHNW is the contract partner for SERI, HSG and ETHZ are compensated for their contribution to the project by FHNW.

Dominique Foray

Professor, prof. em. EPFL

Prof. Dr. Dominique Foray is professor emeritus at the EPF Lausanne. His research focuses on the microeconomics of innovation, of knowledge and of related institutions. He joined the National Center for Scientific Research CNRS (Lyon), was a professor at the Ecole Centrale de Paris, research director at CNRS and principal analyst at the OECD. Between 2007 and 2010, he chaired the European Commission's Knowledge for Growth expert group, and since then has widely contributed to the development of the EU smart specialisation policy concept, of which he is the author. Between 2012 and 2015, he was the foreign member of the German Expert Commission on Research and Innovation (EFI), and has recently served on the Expert Group for the first Swiss National Report on Research and Innovation. He is a member of the advisory board of the KOF Swiss Economic Institute (KOF/ETHZ) and since 2016 also of the Swiss Science Council.

Franz Barjak

Professor, lead of FHNW team, overall coordination

Franz Barjak is professor for Empirical Social and Economic Research at the School of Business of the University of Applied Sciences and Arts Northwestern Switzerland (FHNW). He has led or contributed to numerous research projects in the fields of innovation research, technology transfer, science and technology studies, scientometrics, Internet studies and regional economics. His work has been sponsored by different Directorate Generals of the European Commission, Swiss and German public authorities, universities and academic institutions, companies, and industry associations.

Martin Wörter

Professor, lead of ETHZ team

Martin Wörter heads the Innovation Division at the ETH Zurich, KOF Swiss Economic Institute and is an Adjunct Professor at the Department of Management, Technology and Economics at ETH Zurich. His research focuses on the field of innovation economics. Before coming to ETH Zurich, he worked at WIK (Scientific institute for communication services) in Germany, at the Academy of Sciences in Vienna and at the University of Innsbruck. As part of his dissertation, he also conducted research at SPRU (Science and Technology Policy Research) in Brighton (England) and at the University of Marburg (Germany). Relevant publications on this project can also be found on ORCID: https://orcid.org/0000-0003-4467-9134 and on the KOF website.

Benoit Cornet

Dr., lead of HSG team

Dr. Benoit Cornet holds a PhD in finance from EPFL, and is currently a post-doctoral researcher at the Center for Aviation and Space Competence of the University of St.Gallen. He also holds a Master in Management and a Master in Macroeconomics and European Policies. His research interests include finance, econometrics and innovation policy. Dr. Cornet previously worked as a consultant in strategy and management for KPMG, and as external experts for a private bank in Geneva. He is currently working closely with Prof. Foray

on various innovation policy projects for the confederation and international agencies. He is lead author of several papers sent to top-tier journals (e.g. Technological Forecasting and Social Change) and conferences (Eu-SPRI).

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