Technological Forecasting & Social Change 80 (2013) 1035–1049

Contents lists available at SciVerse ScienceDirect

Technological Forecasting & Social Change

Analyzing and improving the national innovation system of highly developed countries — The case of Switzerland

Christian Marxt [a,b,*,1], Claudia Brunner [a,2]

[a] University of Liechtenstein, Institute for Entrepreneurship, Fuerst-Franz-Josef-Strasse, 9490 Vaduz, Liechtenstein
[b] ETH Zürich, Department for Management, Technology and Economics, Kreuzplatz 5, 8032 Zurich, Switzerland

ARTICLE INFO

Article history:
Received 9 January 2012
Received in revised form 12 July 2012
Accepted 14 July 2012
Available online 21 December 2012

Keywords:
National innovation system
NIS
Highly developed country

ABSTRACT

According to the European Innovation Scoreboard, Switzerland is the innovation leader in Europe. Switzerland surpasses countries such as Finland, Sweden or Germany in most of the relevant indicators. Additionally, Switzerland is also one of the most competitive countries in the world, as investigated by the World Economic Forum. This paper addresses the question, how the country can keep its leading position by enlarging and strengthening the national innovation system in a sustainable way. Using a systemic approach, in particular an adapted national innovation system framework, this study analyses the current innovation system of Switzerland and comes up with nine recommendations for improvement. Two years after the presentation of these findings to the Swiss government, this study is also able to report on the implementation of some of these recommendations. Method wise, it is a result of a series of interviews and workshops with major stakeholders in the innovation field in Switzerland combined with the analysis of secondary data from multiple sources.

1. Introduction

The term national innovation system (NIS) was first coined by Freeman and Lundvall in the 1980s [1,2]. While Lundvall [2] originally distinguished between a narrow and a broad definition of national innovation system, today the broad definition is commonly used [3,4]. Next to "organizations and institutions involved in searching and exploring — such as R&D departments, technological institutes and universities" [4], the broader view on NIS includes the diffusion, absorption and use of innovation [4,5]. Additionally e.g. R&D efforts by business firms and public actors, learning processes, incentive mechanisms or the availability of skilled labor as well as interactions between organizations and institutions are also included [6]. Consequentially this broader definition is based on a systemic approach rather than linear push and pull processes. Lundvall and Borras [7] and Lundvall [3] describe this change as movement from "Science Policy" and "Technology Policy" towards "Innovation Policy".

Especially in recent years, research on this area has increased and numerous publications focus on innovation policy. The terms 'national innovation system' (NIS) or 'national system of innovation' (NSI) describe this research stream best and well-known articles and analyses use this approach to benchmark or detail on the innovation capacity and potential of countries or whole regions (compare with the Literature review section). In the following we will use NIS as an abbreviation for both terms synonymously.

With a detailed literature study, we identify three basic types of publications on NIS: NIS studies in general; NIS studies with a focus on particular aspects of the NIS and theoretical perspectives on NIS. Even though quite a number of articles analyze the NIS of a single country in detail, none of these studies on a developed country is able to draw implications on how to improve the current

* Corresponding author at: University of Liechtenstein, Institute for Entrepreneurship, Fuerst-Franz-Josef-Strasse, 9490 Vaduz, Liechtenstein. Tel.: +423 265 1276; fax: +423 265 1271.
E-mail addresses: Christian.Marxt@uni.li, cmarxt@ethz.ch (C. Marxt), Claudia.Brunner@uni.li (C. Brunner).
URL's: http://www.uni.li, http://www.ethz.ch (C. Marxt), http://www.uni.li (C. Brunner).
[1] Tel.: +41 44 632 05 41; fax: +41 44 632 10 45.
[2] Tel.: +423 265 1288; fax: +423 265 1271.

0040-1625/$ – see front matter © 2012 Published by Elsevier Inc.
doi:10.1016/j.techfore.2012.07.008

system and at the same time report on changes being made, after these recommendations were issued. Hence, this study will go into detail on the very far developed country of Switzerland, using a start-to-end approach.

By using a systemic approach, this study is not only able to develop recommendations for improvement for the NIS of one of the world's leading innovators, but also to report on the implementation of several of these recommendations. After a thorough analysis of Switzerland's national innovation system and a number of workshops and discussion sessions, the authors propose nine recommendations on how to enlarge and strengthen the Swiss innovation system in a sustainable way, so the country may keep its leading position or even extend its lead.

Methodically, we compiled a literature review and analyzed a large number of secondary data. Based on that we conducted a series of expert interviews, workshops with major stakeholders as well as discussion sessions with a consulting counsel of the government.

1.1. Switzerland

Switzerland, also the Swiss Confederation, is a relatively small country in the middle of Europe. It is bordered by Germany in the north, Austria and Liechtenstein in the east, Italy in the south and France in the west. The country was founded in 1848 and enfolds 41.285 km^2. The 7.8 Mio inhabitants speak four official languages. Switzerland is a very rich country and achieved a GDP of 69.838$ per capita in 2010 and still has its own currency, the Swiss Franc [8].

The Swiss innovation system ranks among the best in Europe [9–12] (compare with Fig. 1). One major source of this excellent position is the outstanding reputation of Switzerland's universities and scientific research facilities (compare with Tables 1 and 2).

This reputation is mirrored in a ranking of per capita publications, which is headed by Switzerland [13]. Apart from that, Swiss companies also contribute with a substantial amount of R&D spending to the innovation performance of Switzerland [11,14].

Even though Switzerland seemingly succeeds in comparison to other European countries, weak spots can still be identified when having a closer look [11,12] (compare with Section 6).

2. Literature review

To uncover literature, which is concerned with national innovation system-related topics, a literature research in major databases (e.g. Ebsco and ABI/Inform) was conducted. The search of "national innovation system" or "national system of innovation" in keywords, title and abstract yielded 45 results with a direct relation to the subject. Unrelated articles were manually removed from the subsequent data.

According to Balzat and Hanusch [6], many research on NIS use systemic approaches and among those, they distinguish between performance-oriented studies and NIS studies of low- and mid-income countries or regions.

Following our own literature study, we found another distinction for the articles and divide in three basic types of articles on NIS:

- firstly NIS studies in general,
- secondly NIS studies, which focus on particular aspects of the NIS
- and thirdly theoretical aspects of NIS.

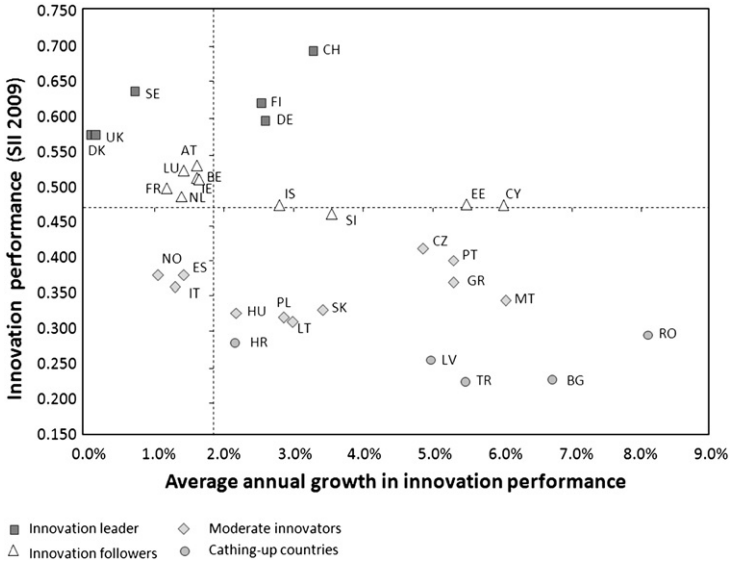

Fig. 1. European Innovation Scoreboard (EIS) — SII and growth 2009 [11,12]. Unfortunately newer versions of the EIS do no longer show Switzerland in this particular graph.

Table 1
Swiss universalities in the Times Higher Education Ranking.

Swiss universities	Ranking THE (Times Higher Education)
ETH Zürich (Swiss Federal Institute of Technology Zürich)	15
ETh Lausanne (Ecole Polytechnique Federale de Lausanne University of Zürich)	46
University of Zürich	61
University of Basel	111
University of Bern	112
Universite de Lausanne	116
University of Geneva	130

When NIS studies themselves are concerned, studies for all kinds of countries can be found. Among those, ten studies are concerned with single countries, whereof seven are developed economies; two focus on newly industrialized economies and one on a developing country. Five other NIS studies compare countries within regions with a benchmarking approach.

Studies, which focus on particular aspects of the NIS can also be found for any type of country: from single country studies of newly industrialized economics to comparisons of developed and developing countries. Those studies investigate certain aspects of the NIS in depth. E.g. Campagnac [15] looks at the influence on the construction sector in France, Chen [16] examines the interplay of foreign R&D investments and Taiwan's NIS and Ibata-Arens [17] compares national policies targeting life science in Japan and the USA, just to name a few.

Another eight articles examine theoretical aspects of NIS, rather than going in the analysis of countries. E.g. Nasierowski [18] identifies the extent to which the decrease in productivity growth can be explained by differences in efficiency and components of their NIS; Fromhold-Eisebith [19] is concerned with the question, how innovation systems on various levels can be linked with each other and finally Kravchenko [20] goes into detail about the problem of measuring and assessing NIS.

Altogether a large number of publications on NIS-related topics can be found, among those quite a number of articles are on NIS in developed countries (compare with Appendix 1). However, the scope of these articles is mostly about the current situation or the historical development of the country's NIS. So far only a small number of publications in the sample are able to come up with recommendations to improve the current situation and no study of a developed economy is able to observe changes being made.

3. Method

In order to go all the way from the analysis of the current situation, to the development and implementation of recommendations, it was firstly necessary to use various methods and secondly to comprise major stakeholders into the process.

In a first step, a thorough literature review was conducted and secondary data carefully investigated. Among those was material from WEF (World Economic Forum), Eurostat, OECD, the European Union or the Federal Statistical Office of Switzerland. The compilation of this data proved necessary and very valuable, since Switzerland does not yet dispose of any innovation monitoring agency or system.

In a second step over a period of 9 months (January 2009–September 2009), a series of expert interviews, workshops and discussion sessions were conducted (compare with Fig. 2) [55].

Two expert interviews with members of a cantonal innovation funding agency, one with the chief of staff of the Swiss Science and Technology Council (SSTC), one with a member of the board of the federal innovation funding agency (CTI) and one with the director of technology transfer of a local university yielded valuable insights (Fig. 8). Five subsequent discussion sessions with all members of the SSTC, and three workshops with selected members of the SSTC, the so called 'workgroup innovation', deepened the insights and finally led to the development of nine recommendations to further improve the Swiss innovation system (compare with Appendix 2).

For all workshops and discussion sessions, detailed protocols were prepared during the meetings by administrative staff. These protocols and further references built the basis for the following meetings and ultimately for the development of the recommendations. Resulting especially from in-depth discussions with selected members of the SSTC ('workgroup innovation') first drafts of recommendations could be drawn, which subsequently came out in the discussion in meetings with all members of the SSTC. These steps and iterations were on the one hand necessary to validate the recommendations and on the other hand to ensure the incorporation of inputs from various perspectives and disciplines on innovation. The broad scope of disciplines of the discussion members proved extremely helpful to consider various forms and types of innovation and not focus on economic issues alone.

Table 2
Swiss research facilities and their annual budget.

Research facilities	Annual budget 2012
CERN (European Organization for Nuclear Research)	CHF 1098.6 Mio (2009)
EAWAG (Swiss Federal Institute of Aquatic Science and Technology)	CHF 52.6 Mio
PSI (Paul-Scherrer Institute)	CHF 242.8 Mio
EMPA (Swiss Federal Laboratories for Materials Science and Technology)	CHF 90.4 Mio

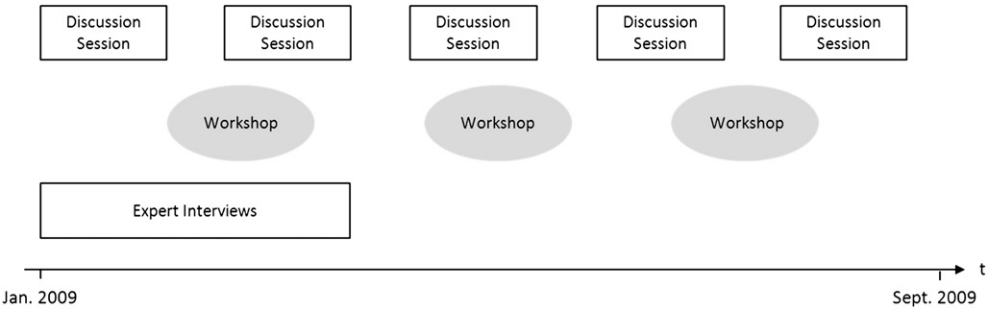

Fig. 2. Time line of interviews, discussion sessions and workshops.

Due to governmental regulation, the documents, including protocols, are not available for the public and hence may not be published according to their wording. During the process however, all documents were generally available to all participants and interviewees.

4. A systemic approach

The basis of the following analysis is constituted by a systemic concept of the Swiss innovation system, as proposed by Balzat [6], Lundvall and Hotz-Hart et al. [3,27]. Hence, innovation is seen as a non-linear and multidisciplinary process, where interaction on the organizational level and between organizations and institutions is central [6]. In particular, this study is based on a systemic concept similar to that of Porters [56,57], with the innovative organization in the focus of analysis. Enabler, suppliers, processes in the innovation system as well as other actors influence the innovative organization and together innovation is achieved. Additionally surrounding conditions impact innovation (compare with Fig. 3).

5. State of the art analysis — Switzerland

For each part of the state of the art analysis, we use comprehensive literature review and secondary data as basis. In addition, several interviews with distinguished experts were conducted to enhance the results. For example for the analysis of the processes in the innovation system, we interviewed a member of the board of the Swiss innovation funding agency and the director of technology transfer of the ETH Zürich. When focusing on the cantons and their influence, we interviewed three experts from cantonal innovation promotion agencies, such as the director or the cluster manager (compare with the Method section).

For all upcoming topics of analysis, a more exhaustive report of almost 100 pages, which bundles all results, is available.[3]

5.1. Processes

Basically, in an innovation system, two main processes and several support processes can be distinguished. All of those can lead to three different kinds of innovation. Firstly, result-oriented innovation can happen, among those products and services. Secondly, structure-oriented innovations can occur, such as new and innovative structures and processes within companies and societies. And thirdly, behavioral innovation is also possible. This kind of innovation is concerned with the behavior of individuals, groups or the society as a whole.

The main processes are the actual innovation processes, for one thing the product innovation process, for another thing the process for promoting innovation. Additional support processes are e.g. the knowledge and technology transfer process (KTT) and processes for regional innovation development [9,58].

The process for promoting innovation in particular consists mainly of the activities of the CTI (Commission for Technology and Innovation) and also regional means to promote economic development. The CTI is a public agency with the mission to promote innovation. An annual budget of approximately CHF 100 Mio is granted by the state. The promotion of applied sciences, knowledge- and technology transfer as well as the support of start-ups is part of their work. In particular, market-oriented R&D projects, conducted by both business and universities or universities of applied sciences, are funded. Essential for the funding is always a partnership of these two constituents. Several hundred projects are funded each year. On average the grant amounted to CHF 351,300 during 2008 [58]. These funds are awarded directly to the participating academic institution and not to the companies.

Another relevant process is the process to transfer technology and knowledge from universities to companies. The number of such transfer activities has increased over the last years [59] and is mostly coordinated by dedicated KTT offices at the local universities or universities of applied sciences. Also an increasing interest from companies is observable. In a study of all KTT activities of the Federal Institute of Technology Zürich (ETH Zürich), Inganäs [59] finds an average length of 18 months of such projects. The author furthermore identifies “trust and social connectedness” as well as “common interest” as leading motives and central success factors of these

[3] For further reference: Marxt, C.; Brunner, C. (2009) “Innovationssystem Schweiz — Eine Bestandsaufnahme 2009” [66].

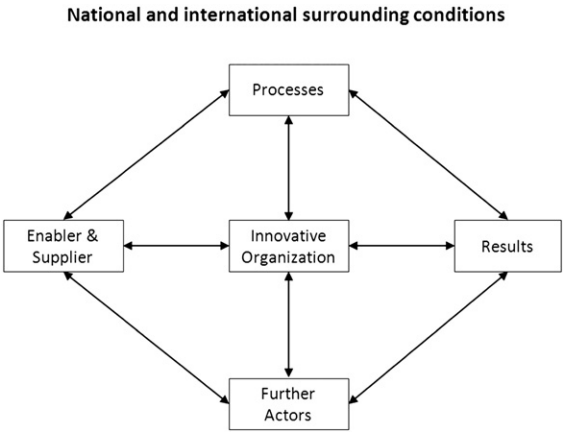

Fig. 3. Model of the innovation system (own depiction based on [56,57]).

activities. A striking result is also a strong regional aspect in KTT activities. According to Inganäs [59] more than 40% of all partnerships happen within a close regional proximity of less than 100 km.

5.2. Breeding environment

The surrounding conditions of the innovation system are composed of different aspects, which can potentially influence the innovative output. These are e.g. the political system and its stability, legal aspects, competitive regulation, such as the protection of intellectual property, fiscal aspects, the provision of infrastructure and public spending.

Switzerland as a whole is economically very well developed and politically very stable [60]. One of the most striking aspects when looking at Switzerland is its strong federalism. A great part of innovation funding is controlled and decided by the 26 cantons. This fragmentation sometimes leads to delays in decision-making, but also ensures a continuous and sustainable development.

Also controlled by the cantons is the effective taxation rate, which is between 13.8 and 22.8% and quite low in an international comparison.

Next to a fragmentation in decision-making, Switzerland's policy on innovation is at the time of the study (2009) not very well coordinated. In 2009 basic laws for innovation are in place, but are not really suitable for making funding decisions. One reason lies surely in the federalism, another one in the distribution of the regulation into various laws and finally in a lacking comprehensive innovation policy.

5.3. Enabler and supplier

In this area, two major input factors are human resources and the financing of innovation. Further enablers, such as R&D facilities or organizations with a focus on knowledge and technology transfer are equally important. Besides graduates from natural or engineering sciences, students and experts of humanities are also a necessary prerequisite for the creation and implementation of innovation.

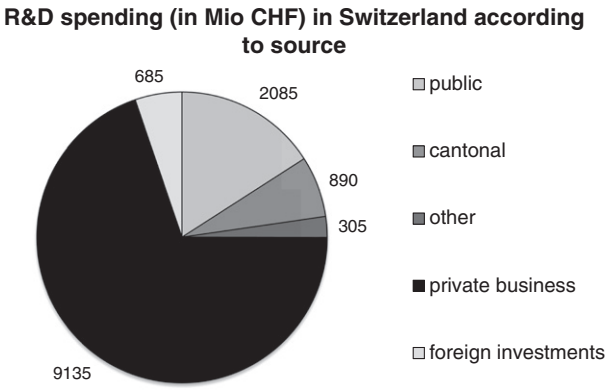

Fig. 4. R&D spending (in Mio CHF) in Switzerland according to source.
Own graph according to [63,11,14].

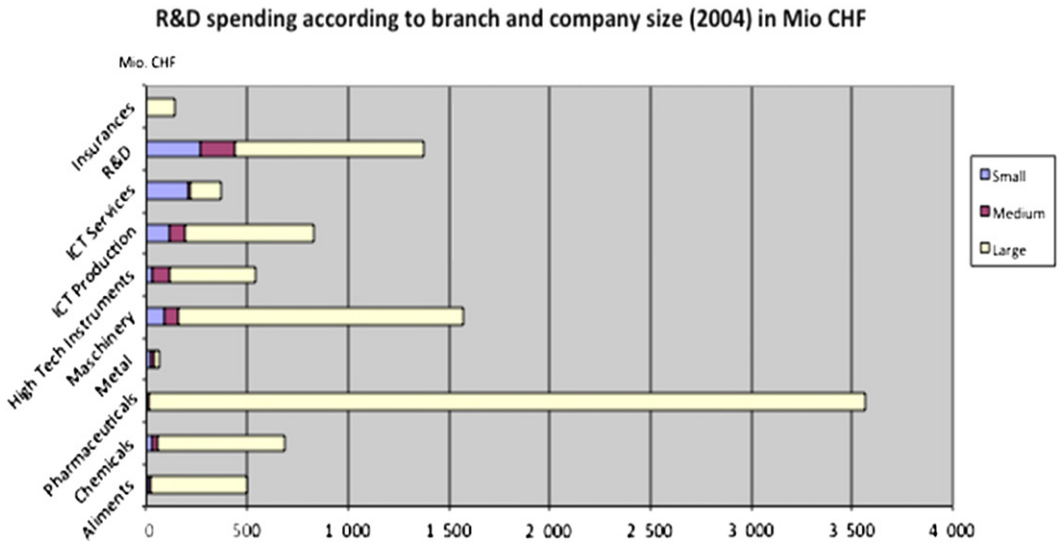

Fig. 5. R&D spending according to branch and company size in Mio CHF (2004). Own graph according to [62].

Furthermore, innovation is not limited to people with tertiary education. Consequentially, looking at a direct correlation of the innovativeness of a country with its quota of tertiary education is not meaningful [61].

However, education and continuing education are central to the enablement of innovation. Therefore, financing this type of education is an important input factor, and both public and private expenditures account for the innovation potential.

In 2009 around 30% of the Swiss population has tertiary education. When compared to all EU-member states this is quite high (EU-average: 23%), however it is far smaller than e.g. in the United States (ca. 38%) or Canada (ca. 46%) [62]. The number of people working in R&D per 1000 inhabitants is also quite low. Although slightly above EU-average, Switzerland (12 people/1000) is far behind e.g. Finland (ca. 22 people) [10]. These numbers seem curious, when considering the countries' overall innovation performance.

Especially, since overall expenditures on R&D have continuously topped 2% of GDP, since 1986. This high percentage of R&D spending is only surpassed by Japan and Finland in the OECD area [64]. Also the share spent on education has been above EU-average for more than 20 years (between 5 and 6% of GDP since 1990) [64]. And finally, Switzerland disposes of excellent universities (e.g. ETH Zürich in top 20 of Times Higher Education Ranking), world-renowned research facilities (e.g. CERN) as well as a number of regional KTT institutions, which are mainly Science & Technology Parks (compare with the Introduction section).

5.4. Further actors

5.4.1. State

The state plays a major role when the advancement of innovation is concerned. As of the time of the study (2009), the Swiss government defines innovation as an accomplishment, which is primarily achieved by research. This definition of innovation is

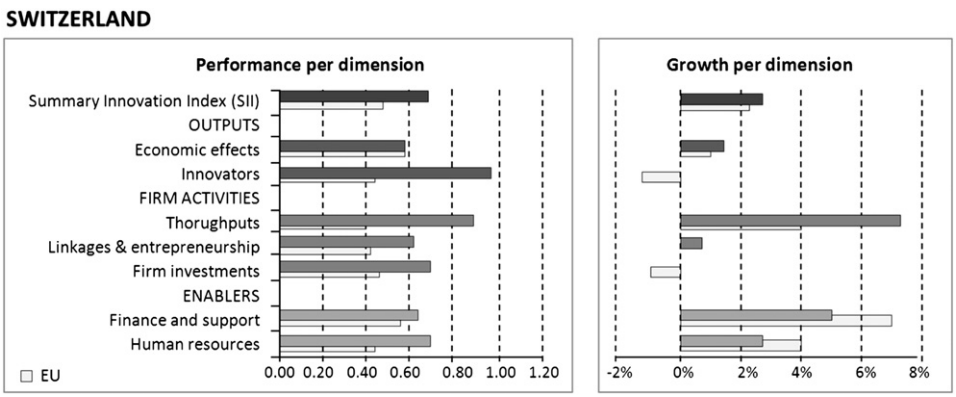

Fig. 6. Country profile Switzerland in regard to innovative performance and growth [11,12].

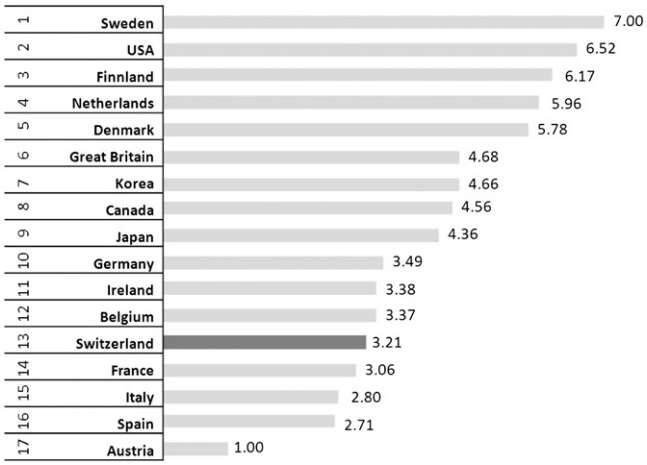

Fig. 7. Overall performance of societal climate for innovation 2008 [67].

limited and does not include the commercial exploitation of the results of research. As a consequence, the state focuses for one thing on the CTI (Commission for Technology and Innovation) and for another thing on sponsoring education and research. Other or advanced means to promote innovation are neither intended nor regulatory wanted by the government. A future distinction between means to promote innovation and means to support research is recommendable.

The competences for the realization of the innovation or research funding mechanisms are distributed to various agencies, among those are the Federal Department of Home Affairs (FDHA), the Federal Department of Economic Affairs (FDEA) and the Federal Office for Professional Education and Technology (OPET). Consequentially a combined and aligned innovation policy was not in place in 2009.

Strength	**Weaknesses**
• Top ranks in research • Top ranks in innovative performance • High R&D spendings of private sector • High number of employees in knowledge intensive services • Very good infrastructure	• No coherent innovations policy and according instruments for the implementation • Commercial implementation of results of scientific research in products • Societal climate for innovation and implementation • Data quality • Surrounding conditions and opportunities for financing of start-ups and spin-offs • Amounts of funding for innovation
Opportunities	**Threats**
• Simplify and strenghten collaboration of universities and business • Establishment of centers for innovation • Promotion of non-technical innovation • Further development of (continuing) education • Sustainable and coordinated communication of Switzerland as place for innovation • Export of knowledge intensive services	• Changes in the macroeconomic surrounding (e.g. economic cycle; global competition) • Intensification of competitive regulation (e.g. worsening of fiscal situation for business)

Fig. 8. SWOT—analysis of the Swiss innovation system.

In addition, those agencies currently only have access to 3–5 year old data to build their decision on. This lack of up-to-date data is a result of the prevailing structures in the government and also in the absence of an adequate innovation monitoring system.

5.4.2. Cantons

Innovative activities in the cantons are part of the NRP (New Regional Politics) and various cantonal acts on economic promotion. The NRP consists of three different directions and aims at the promotion of innovation and the development of a market-oriented economy. It wishes to enhance the regional competitiveness and the adaptation of local business to new conditions under globalization. Projects, initiatives and programs are directly supported [65].

The NRP focuses firstly on the "promotion of regional economy", secondly on the "coordination of regional politics with federal agencies" and thirdly on the "know-how for regional politics and politicians as well as stakeholders". It is restricted to non-hub-cantons. Especially from the second focus, it becomes clear, that the decisions on how to promote innovation are widely distributed in the country [65,66].

5.5. Innovative organization

Many of the before mentioned conditions as a whole are very favorable for local companies as well as the settlement of foreign business in Switzerland. Among others, legal security on intellectual property issues supports efforts of companies to conduct R&D in the country and thereby ensures large amounts of R&D spending.

In general, business is the main carrier of the innovative performance of Switzerland, this is almost independent of company size. Altogether the amount of R&D spending from public authorities (state 16% and cantons 7%) is only at 23% of the overall amount, the share of companies however is more than 70% [11,14,63] (compare with Fig. 4).

When the total amount of private R&D spending is further broken down, a clear focus on companies in the pharmaceutical sector becomes evident and also quite logically large firms are responsible for the most spending (compare with Fig. 5).

In general it can be said, that companies with different sizes face different challenges in Switzerland, when their innovative activities are concerned. Especially for multinational companies (MNC) Switzerland offers quite attractive conditions. For one thing, the location itself is appealing, especially highly qualified people are attracted to the high standards of living. For another thing, large companies are granted easy access to local universities and hence only very rarely have problems with knowledge transfer and the recruiting of qualified graduates. Small and medium sized enterprises on the other hand often have problems when hoping to conduct KTT with universities and in many cases simply cannot afford to hire qualified graduates due to the extremely high salary structures in the country.

6. Findings

6.1. Innovation

Switzerland is top ranked in terms of innovation performance in the European Innovation Scoreboard in 2008 and 2010 compared to 27 EU-countries [11,12]. In all measured indicators, Switzerland is above average. Especially impressive is the relation in terms of throughputs and innovators. While in 2008 "economic effects" and "linkages & entrepreneurship" (compare with Fig. 6) were still above average, in 2010 "linkages & entrepreneurship" becomes one of the weaknesses of Switzerland [12]. Especially the innovating power of SMEs seems to have declined over the years.

A relatively very high growth rate was reached in throughputs, smaller growth rates can be observed with the enablers, human resources and finance and support. However, factors from this area, primarily an increase of venture capital and an increase in the number of PhD graduates, are key elements for the improvement of the overall innovations performance [11].

When having a closer look at the results, weak points in the Swiss innovation system, which have the potential for optimization, can be identified.

In relation to the average of 27 EU countries, Switzerland realizes fewer products, which are new to the firm, compared to products, which are new to the market. The performance in "new to market products" being better than in the area "new to firm products" implies a tendency of Swiss companies to adapt and integrate products from other markets into their portfolio rather than developing new products. And also, it seems necessary to strengthen SMEs in terms of innovation power.

6.2. Societal climate for innovation

In contrast to its innovative power, Switzerland is less successful, when soft factors are concerned. The German Institute for Economic Research (DIW — Deutsches Institut für Wirtschaftsforschung) publishes annual studies (e.g. "Innovationsindikator Deutschland 2011"), which among others focuses on the social climate for innovation in several countries. This evaluation for the social climate is composed of several indicators, such as the 'willingness of the people to undertake entrepreneurial risks', 'degree of openness and tolerance', the 'positive attitude to the participation of women', a 'positive attitude to science and technology', the 'support for sciences' and the 'trust in innovation actors' [67].

In the overall ranking, Switzerland is close to the bottom at position 13 out of 17 countries, far behind Sweden, the United States and Finland, which rank at the top (compare with Fig. 7).

One of the before mentioned indicators is particularly low ranked. When considering the high level of education in Switzerland and the emphasis of the government on education and research, it is even more amazing, to see Switzerland on position 16 out of 17 countries in the indicators 'positive attitude to science and technology' and 'support for sciences'. On the other hand, Switzerland scores very high (position 5) in the indicator "openness and tolerance" [67].

6.3. Analysis

From the analysis of the current situation of the Swiss innovation system, it becomes clear, that the system is multifaceted. While overall it is very successful and elaborate, a number of weak points can be observed and lessen its performance. Additionally, external threats and opportunities influence the system. Some of the major aspects are depicted in the following chart. The composition of the strengths, weaknesses, opportunities and threats of and to the Swiss innovation system is based on a joint work effort with the members of the workgroup innovation of the Swiss Science and Technology Council. Three workshops were necessary to argue and decide on the crucial points (compare with the Method section).

6.3.1. Strengths

Switzerland is top ranked in comparison to all European countries in terms of innovative performance. Also the ranking in academia is excellent, even more so in regard of its publication performance. Additionally, Switzerland disposes of one of the best education systems. Lifelong learning is also actively supported. Both the number of employees in knowledge intensive services and the expenditure of business on R&D is way above average. Especially the share of money, which is dedicated for basic research, is large. Finally, Switzerland still has one of the best infrastructures of Europe and very favorable conditions for the settlement of companies.

6.3.2. Weaknesses

As of 2009, Switzerland did neither dispose of a coherent innovation policy, nor of according instruments for implementation. The CTI (Commission for Technology and Innovation) is the positive exception and the state uses this agency to support innovation directly, even though the amount of the funding per participating company is quite small in comparison to other countries. The opportunities for financing and the surrounding conditions for start-ups and spin-offs, as well as the available data quality are suboptimal. Peculiar is the poor realization of results from scientific research in commercial products and the quite bad societal climate for innovation.

6.3.3. Opportunities

Even though Switzerland is top ranked in its innovation performance, some weak points can be identified and opportunities to remove those become evident. E.g. an enhanced demand for knowledge intensive services can have a positive influence. Another big opportunity lies in a change of Switzerland's image and reputation to a science and service hub and of course in the communication of this change. Furthermore, the promotion of KTT between universities or universities of applied sciences with SME could enhance the countries' innovation performance. Next to an enlargement of the current budget for innovation funding, a second focus could lie in the inclusion of the promotion of non-technical innovation into the existing funding programs or else the creation of new specialized funding mechanisms. And finally, the installment of a coherent innovation policy could help to organize and coordinate all efforts better.

6.3.4. Threats

Threats for the Swiss innovation system can result from a change in the economic structure and development. Financial as well as economic crises are particular risky. Currency risks occur. With its own currency and a strong focus on export, in particular to the European Union, Switzerland is strongly dependent on exchange rates. Already in 2011, Switzerland had to set a minimum exchange rate to the Euro in order to secure its exports.

Increasing global competition and an intensification of the competition for geographic locations could also be a threat. This is particularly risky, since already today e.g. production and labor is extremely expansive, when compared to other countries.

A too strong competitive regulation or a tax rise, in Switzerland and the European Union, might provoke a decline of new settlement of business.

7. Recommendations

Based on the analysis of the current Swiss innovation system, this article depicted nine recommendations for a future successful innovation system.[4] Those recommendations were developed in accordance with members of the Swiss Science and Technology Council. Several discussion sessions were necessary to identify recommendations, which are considered as fruitful and suit the special conditions of an already very far developed and successful country. On the one hand latter point posed quite a challenge. From the first impression one could conclude, that there is not much room for improvement. On the other hand, it was

[4] For further reference: [68] C. Marxt, S. Nigsch, Neun Empfehlungen zur Förderung der Innovation in der Schweiz, in 'Schweizer Wissenschafts- und Technologierat (SWTR)', 2009.

especially this challenge, which made the task interesting. And in fact, even though Switzerland is clearly in the lead in the EU, some weak spots can be identified. In some cases these weak spots are unexpectedly large, e.g. when a lacking coherent innovation policy is concerned.

Following a thorough analysis of the NIS (including interviews and the consultation of secondary data), the SWOT was compiled in a joint effort with the "workgroup innovation". In these workshops, a first draft of recommendations was also developed. These recommendations were finalized and strongly discussed with all members of the SSTC in dedicated sessions.

Developing and installing a coherent national innovation policy is recommended. The promotion of innovation is a complex cross-sectional task, which needs wide support:

- Therefore, *it is necessary to develop a coherent national innovation policy and trans-sectorial instruments for its implementation.*

Switzerland already disposes of a very well established innovation-funding agency (CTI). On the down side however, project volumes are way smaller, than e.g. in the United States and the agency has not enough impact yet. Hence, these instruments are to be expanded:

- *Existing institutions and instruments for the promotion of innovation are to be enlarged: The Commission for Technology and Innovation (CTI) is supposed to use its new autonomy and flexibility, to adapt to the actual requirements of business.*

On the one hand, a lot of people are interested in starting a business, among those many scientists. Unfortunately, the access to financial capital is difficult and a substantial administrative effort is necessary to start a business depending on type and sector. Therefore, the breeding environment for start-ups and spin-offs has to be improved:

- *The transfer of results of scientific research with excellent innovation potential is to be promoted by enhancing the surrounding conditions and means for financing spin-offs and start-ups.*

Innovative companies account for a significant share of the economic and innovative performance of the country. They are furthermore important partners for universities, not least to their provision of funding. Above all, the country has to ensure the necessary access to qualified people, who are ultimately responsible for innovation:

- *The collaboration and the knowledge transfer between universities and innovative companies are to be supported by long-lasting firm and at the same time open-minded regulatory conditions. The access to human resources, particularly in natural and engineering sciences, has to be ensured both national and international.*

In Switzerland, KTT activities mostly happen between universities and MNCs. Universities of applied sciences and SMEs are underrepresented, even though they and the country's innovation performance could profit a lot:

- *To enhance the access to academic knowledge and scientific research results, especially for SME, regional innovation centers with a focus on specific Swiss requirements shall be established.*

Knowledge-intensive services gain increasingly in importance. Even though these innovations are not marketable in a classical sense, they are of huge importance for economy and society:

- *To support innovation in non-technical areas, specific funding instruments have to be expanded.*

Coming with a change in society and business is the increased necessity for (continuing) education to cope with new technologies, etc. Only sufficient knowledge about them allows for new innovative applications:

- *Requirements in regard to communication technology increase for society and business. An effective offer of education and continuing education to close this gap is necessary, to capture these opportunities for innovation.*

Today, decisions influencing the national innovation system are mostly based on significantly old data. An effective decision-making is consequentially only possible in a limited way:

- *A national monitoring system for innovative performance will have to be established, in order to be able to provide data for effective decisions.*

Communication about Switzerland as the home of excellent innovation is both important within the country and outside of it. On the one hand, awareness about the importance of innovation has to be generated in the Swiss society, on the other hand, successfully innovating companies need to be attracted to Switzerland:

- *A sustainable and coherent national and international communication of the "innovation hub Switzerland" is to be continued and enhanced further.*

8. Proceeding and implications for Switzerland

This review on the Swiss innovation system was compiled in mandate of the Swiss Science and Technology Council. The SSTC is the advisory body to the Federal Government for issues related to science, higher education, research and technology policy in Switzerland. The recommendations depicted in the article, together with an extensive version of the report, were directly presented

to the Swiss government. As of 2012, several of the recommendations and findings already seem to have supported the ongoing change efforts.

For one thing, the government has revised the act on research and innovation in 2010 [69].[5] This is a first huge step to a coherent national innovation policy, as recommended in point 1.

The state wishes to promote the knowledge transfer from universities to business. Specifically interesting and application-oriented projects shall be supported through optimal surrounding conditions for the actors.

Significant increases in the budget of the CTI for promoting innovation have taken place. In 2011, the CTI received extra-funds amounting to 100 million Swiss Francs (recommendation 2), which effectively doubles the budget [70]. In November 2011, more than 600 project proposals were filed in addition to the usual number.

And finally, regional innovation centers (recommendation 5) are under development since 2011. E.g. in eastern Switzerland, an innovation center with the focus on engineering technologies is set up in 2012.

Shortages and delays regarding some recommendations can also be observed. Surrounding conditions for financing spin-offs and start-ups, as well as a promotion of KTT activities has not yet happened. The access to human resources in engineering and natural sciences is not yet ensured to a satisfactory extent and still no means are in place to promote innovation in non-technical areas. Also, no additional education offerings in regard to communication technologies are observable. And finally, the country still falls short on a national monitoring system for innovation performance and a sustainable and coherent communication policy.

9. Limitations and conclusions

Several interviews and workshops as well as an extensive research in secondary literature allowed analyzing Switzerland's innovation policy. A number of success factors, but also weak points could be identified. In a next step, nine recommendations were developed in a joint approach, on how to improve the current situation further or at least keep the leading position. In a final step, those recommendations were handed over to the Swiss government. Two years later (in 2011/2012), first developments and the implementation of some of the recommendations can be observed.

Some insights and discussion points can be drawn from this comprehensive study. First of all, it becomes evident, that it is worth the effort to investigate if there are any possibilities for improvement, even if a country is already a successful innovator. On the other hand, some of the identified success factors may serve as a role model for less developed countries. Although Switzerland is a unique country with unique characteristics, some of the findings can be conveyed to other countries, no matter how far developed. Lessons can be learned from the OECD innovation leader and the findings and recommendations may serve for discussion purposes as well.

Switzerland is indeed very special. Next to tourism and agriculture, the country lives solely from its “brains”. Consequentially, Switzerland's government has a focus on education and spends very high amounts of money on this resource. However, the quota of people with tertiary education is still on a mediocre level. Also the overall spending on R&D is very high as well, but in contrast the number of people working in R&D is much lower than in other countries in Europe. It is however unclear, whether this means high productivity or something else. Adding to the latter fact is the low percentage of public spending in contrast to the very high spending from private institutions. Obviously, Switzerland manages to attract large and successful corporations into the country and profits from them. Supporting the notion of Alvarenz/Marin [50] on how to attract companies, Switzerland seems to offer all categories. From low effective taxation, legal security, very good infrastructure up to very high standards of living, everything is available to a high degree. Additionally, the strong regionalism in Switzerland allows for competition between the regions within the country, which again furthers Switzerland's attractiveness. Regions have to try hard to attract companies, before their neighbors do. In some cases, the promotion of innovation activities is even outsourced to a private institution, which takes care of all questions and problems in this area.

And finally, the country is the home of extraordinary research facilities and universities, which bring very talented people into the country and in many cases, compensate for the small number of highly qualified Swiss citizens.

To sum these results up, distinct lessons can be learned from Switzerland. First of all, optimal surrounding conditions have to be provided to attract foreign companies, which to a great extent are responsible for the country's innovative performance. Also, a balance has to be found between the attraction of foreign companies and the support for local SMEs, which also take a vital part in the country's innovation performance. It furthermore has to ensure, that all companies are enabled and even encouraged to innovate. Coming with that, a competition between the regions to become most attractive to companies, improves the overall attractiveness. Additionally, talents and high-potentials from foreign countries have to be attracted and conditions must be adapted, so that these talents want to stay and can stay for a longer period.

Unfortunately, it is unsure, how far these results can be generalized. Depending on the state of development, the geographical location or the history of countries, only small parts, or single recommendations can be generalized. This is even more hindered, since no single success factors of Switzerland could be identified. Only bundles of means and of course their relation to the situation of the country, became apparent. Again, one will have to be careful to generalize findings from this study, and there is the need to adapt the findings to the local situation. An additional factor limiting the study is the unknown long-term effect of the induced policy changes. A follow-up study in 3–5 years will give valuable insights and evaluate, which recommendations really made a change and find details, which changes were successful. Overall, it will be interesting to investigate, what really is a success when changes are implemented in a national innovation system. Can e.g. success be measured in terms of number of patents filed or economic performance, etc.? And finally, it might be very interesting, to investigate, whether a coherent innovation policy in fact is a success factor, or merely “nice-to-have”.

[5] For further details compare with “Bildung, Forschung und Innovation 2008–2011” Federal Office for Professional Education and Technology, 2007.

Appendix 1. Results of a literature study in major databases including their topics in brief, their focus, the countries and the region. Results are ordered according to their year of publication

Article(s)	Topic	Focus	Country/countries	Region
[15]	Presents the French NIS in the construction sector, and points out its strengths and its weaknesses, through the analysis of specific institutions.	Particular aspect of NIS	France	Developed economy
[21]	The article brings out fundamental similarities and differences between two sets of ideas that overlap in important respects, but where little cross-referencing can be found: National business systems and NIS	Theoretical aspect of NIS	n.a.	n.a.
[22]	The paper presents a quantitatively based method for comparing the structure of NSI. The emphasis is on technological interdependencies in the mentioned countries.	Particular aspect of NIS	Germany, UK, Japan, USA	Developed economies
[23]	The NIS approach is used as the analytical framework for assessing the state of innovation measures in Cyprus, along with a presentation of some recent research findings in the field.	NIS study	Cyprus	Developed economy
[24]	The article analyzes the innovation policy in the Czech Republic as well as its development over the last years.	NIS study	Czech Republic	Developed economy
[25]	The paper addresses the question, if a coherent national innovation policy could help Hungary to improve the situation.	NIS study	Hungary	Developed economy
[26]	The paper, using Thailand as a case study, aims at understanding the NIS in developing countries, which are less successful in technological catching-up.	particular aspect of NIS	Thailand	Newly industrialized country
[18]	The article identifies the extent to which the decrease in productivity growth of many countries can be explained by differences in efficiency and components of its NIS.	Theoretical aspect of NIS	n.a.	n.a.
[27]	Report on innovation Switzerland, including challenges for business and politics	n.a.	Switzerland	Developed economy
[28]	The article analyzes the Russian NIS with a focus on “new economy”.	NIS study	Russia	Developing economy
[6]	The article defines and explains the development of the systemic approach. It finds two streams of literature in NIS: performance oriented; low- and mid-income countries	Theoretical aspect of NIS	n.a.	n.a.
[29]	The article analyzes recent changes in Singapore's innovation strategies using NIS framework.	Particular aspect of NIS	Singapore	Developed economy
[30]	The paper looks at the process of national scale competitiveness building in a historical perspective and discusses the reasons for the Finish success. It analyzes the main actors and features in the NIS.	NIS study	Finland	Developed economy
[31]	The article examines the NIS of South Africa with a particular focus on its “x-effectiveness”	NIS study	South Africa	Newly industrialized country
[32]	Addresses the question how and which factors (such as networking, environmental factors or the NIS) can influence the technological innovation characteristics of firms in developing countries. Finds policy implications for the country of Iran	Particular aspect of NIS	Iran	Developing economy
[33]	The paper examines the national approach to stimulate innovation in construction. The NSI model is structured with five main actors: local contractors, suppliers, national research institutions, government and foreign contractors	Particular aspect of NIS	Singapore	Developed economy
[34]	The paper analyzes the structure and organization of innovative activities in selected OECD countries.	NIS study	OECD	Developed economies
[35]	The paper focuses on the evolution of NIS in literature	Theoretical aspect of NIS	n.a.	n.a.
[16]	The paper examines the interplay of foreign R&D investments and Taiwan's NIS.	Particular aspect of NIS	Taiwan	Newly industrialized country
[19]	The article is concerned with the question, how innovation systems on various levels (regional, national) can be linked with each other, in order to gain positive effects.	Theoretical aspect of NIS	n.a.	n.a.
[4]	The articles wonders, if the NIS of new EU member states can be improved. It comes to the conclusion that those countries cannot copy the experiences of high income economies, they rather need to adapt them to their specific conditions	Particular aspect of NIS	New EU member states	Developed and developing economies
[3]	Among others, the article details on how and why the concept of NIS came about.	Theoretical aspect of NIS	n.a.	n.a.
[17]	National policies targeting life science in Japan and the USA are compared in the context of their NIS supporting (and hindering) new technology-based entrepreneurship as a whole.	Particular aspect of NIS	Japan, USA	Developed economies
[36]	Analyzes the technological activities and capabilities of foreign affiliates and domestic firms in Thailand and the main mechanisms by which foreign affiliates foster upgrading in domestic firms and in the innovation systems themselves	Particular aspect of NIS	Thailand	Newly industrialized country

Appendix 1 (*continued*)

Article(s)	Topic	Focus	Country/countries	Region
[37]	The article discusses regional and innovation policies in Finland, with special attention focused on centers of expertise, regional centers and multipolis programs.	NIS study	Finland	Developed economy
[38]	The article examines the change of R&D fiscal policies in China since 1978 and its impact on China's drive to become an innovation-oriented country. It is found that policy changes have gradually made enterprises the focal point of the NIS and that correspondingly a new financial and fiscal mechanism has been created to create incentives for innovation in firms.	Particular aspect of NIS	China	Newly industrialized country
[39]	Japan's innovation system is often characterizes as one dominated by in-house R&D, recently more and more firms are involved in R&D collaborations however. The study examines the role of SMEs in this change. Especially new technology based firm's play a central role in changing Japans NIS from an in-house system to a network based one. Policy implications for accelerating this change are also discussed.	Particular aspect of NIS	Japan	Developed economy
[40]	The article outlines some of the distinctive features of Japanese-style innovation both for its historical development and of its likely future shape.	NIS study	Japan	Developed economy
[41]	The articles wonders, if NIS can be a framework for developing countries	Particular aspect of NIS	Developing countries	Developing economies
[42]	The article examines, if and what a focus on arts in the revision of the NIS, has changed. The article find little changes so far and propose further steps.	Particular aspect of NIS	Australia	Developed economy
[43]	The article explores several features of, and changes in the innovation capacity in Asia.	NIS study	Asia	Developed, developing and newly industrialized countries
[44]	The article examines the historical development of the systems approach, long before Freeman and Lundvall introduced NIS	Theoretical aspect of NIS	n.a.	n.a.
[45]	The paper questions, if Australia has a NIS at all.	NIS study	Australia	Developed economy
[46]	Impact of recent reform in academy-run enterprises and their subsequent impact on the national innovation system	Particular aspect of NIS	China	Newly industrialized country
[47]	The paper reconciles diverse efficiency measures to characterize the operating performance of the NIS in 33 countries. The study applies the data envelopment analysis (DEA) approach.	Efficiency measurement of NIS with new approach	Europe and Asia (focus on Korea, Taiwan and Romania)	Developed, developing and newly industrialized countries
[48]	The paper compares Japan and Taiwan with Mainland China in order to examine where China stands in terms of country-level indicators or proactive innovation. It was found that the Taiwanese experience towards proactive innovation lies in between China and Japan in terms of progress on the innovation indicators.	NIS study	China, Japan, Taiwan	Developed and newly industrialized countries
[49]	The article examines the impact of R&D spending (both public and private) against the background of the path to a service-oriented economy.	Particular aspect of NIS	Japan	Developed economy
[50]	The article explores the relative importance of NIS in various forms of firm internationalization. Institutional stability and the consolidation of R&D capacities reinforce entrepreneurship and become key driver mechanisms to improve the attraction of foreign entries.	Theoretical aspect of NIS	n.a.	n.a.
[51]	The literature review aims at analyzing institutions' duties that are active in the NIS and to assess recent developments' contribution to the innovation policy target	Particular aspect of NIS	Turkey	Newly industrialized country
[52]	The study attempts to shed light on the system of innovation approach in a developing country, by analyzing the innovation policy of Thailand. It suggests that while a government might officially adopt the innovation system approach, the practice follows old innovation paradigms and hardly addresses systemic problems.	NIS study	Thailand	Newly industrialized country
[53]	The article analyzes if the Croatian NIS follows the path towards a knowledge economy	Particular aspect of NIS	Croatia	Developed economy
[20]	The article is concerned with the problem of measuring and assessing NIS. It comes to the conclusion, that systemic approaches are more suitable than linear ones, especially against the background of interactions between actors.	Theoretical aspect of NIS	n.a.	n.a.
[54]	The paper investigates to what extent some structured characteristics of NIS and demand affect firms' persistency in terms of innovation investment.	Theoretical aspect of NIS	n.a.	n.a.
[11,12]	Comprehensive benchmarking study of European and some additional countries concerning their innovation performance	NIS study	Europe and USA, Switzerland among others	Developed and developing economies
[9,10]	Reviews for a number of countries including analysis on their innovation performance, policies and strategy	NIS study	several	Developed, developing and newly industrialized countries

Appendix 2. Competence profile of all participants to workshops, discussion sessions and interviews

Function	Affiliation	Gender	Industrial back-ground	Participation		
				Interview	Workshop	Discussion Session
Prof. (Medical Sciences)	SSTC (President)	Female				x
Prof. (Information Science)	SSTC (member innovation circle)	Male	x		x	x
Prof. (Linguistics)	SSTC (member)	Female				x
Prof. (Astrophysics)	SSTC (member)	Male				x
Prof. (Management)	SSTC (member innovation circle)	Male	x	x	x	x
Prof. (Romance Philology)	SSTC (member)	Male				x
Prof. (Music: Piano, Composer)	SSTC (member)	Male				x
Prof. (Cultural Anthropology)	SSTC (member)	Female				x
Prof. (Bioethics)	SSTC (member)	Male				x
Prof. (Biochemistry)	SSTC (member)	Male				x
Prof. (Sociology)	SSTC (member)	Male				x
Prof. (Laws)	SSTC (member)	Male				x
Prof. (Physics and Statistics)	SSTC (member)	Male				x
Prof. (Biology)	SSTC (member)	Male				x
Director promotion of economic development	Cantonal innovation promotion agency	Male	x	x	x	
Cluster Manager	Cantonal innovation promotion agency	Male	x	x	x	
Chief of Staff	SSTC	Male	x	x		x
Member of the Board	Commission for Technology and Innovation	Male	x	x		
Director Technology Transfer	ETH Zürich	Male		x		

References

[1] C. Freeman, Technology Policy and Economic Performance: Lessons from Japan, Pinter, London, 1987.
[2] B.A. Lundvall, Product Innovationn and User–Producer Interaction, Aalborg University Press, Aalborg, 1985.
[3] B.A. Lundvall, National innovation systems — analytical concept and development tool, Ind. Innov. 14 (2007).
[4] U. Varblane, D. Dyker, D. Tamm, N. Von Tunzelmann, Can the national innovation system of the new EU member states be improved, Post Commun. Econ. 19 (2007).
[5] B. Johnson, C. Edquist, B.A. Lundvall, Economic development and the national system of innovation approach, In: First Globelics Conference, Rio de Jainero, 2003.
[6] M. Balzat, H. Hanusch, Recent trends on the research on national innovation systems, J. Evol. Econ. 14 (2004).
[7] B.A. Lundvall, S. Borras, Science, technology, innovation and knowledge policy, In: in: J. Fagerberg, D. Mowery, R.R. Nelson (Eds.), The Oxford Handbook of Innovation, Oxford University Press, Norfolk, 2005.
[8] CIA Factbook, 2011.
[9] OECD, OECD Reviews of Innovation Policy: Switzerland, OECD, Paris, 2006.
[10] OECD, OECD Science, Technology and Industry Outlook (Korea, Israel, Norwegen, Deutschland, Schweden), 2008. (Paris).
[11] Pro Inno Europe, European Innovation Scoreboard 2008, 2009.
[12] Pro Inno Europe, Innovation Union Scoreboard 2010, 2011.
[13] D. King, The Scientific Impact of Nations, Nature 430 (2004) 311–316.
[14] Bundesamt fuer Statistik, Indikatoren Wissenschaft und Technologie in der Schweiz, 2008.
[15] E. Campagnac, National system of innovation in France: Plan Construction et Architecture, Build. Res. Inf. 26 (1998) 291–301.
[16] S.-H. Chen, The national innovation system and foreign R&D: the case of Taiwan, R D Manag. 37 (2007).
[17] K. Ibata-Arens, Comparing national innovation systems in Japan and the United States: push, pull, drag and jump factors in the development of new technology, Asia Pac. Bus. Rev. 14 (2008) 315–338.
[18] W. Nasierowski, On the efficiency of national innovation systems, Socioecon. Plann. Sci. 37 (2003).
[19] M. Fromhold-Eisebith, Bridging scales in innovation policies: how to link regional, national and international innovation systems, Eur. Plann. Stud. 15 (2007).
[20] N.A. Kravchenko, The problem of measuring and assessing national innovation systems, Probl. Econ. Transit. 53 (2011).
[21] B.A. Lundvall, National business systems and national systems of innovation, Int. Stud. Manag. Organ. 29 (1999) 60–77.
[22] I. Drejer, Comparing patterns of industrial interdependence in national systems of innovation — a study of Germany, the United Kingdom, Japan and the United States, Econ. Syst. Res. 12 (2000).
[23] B. Musyck, A. Hadjimanolis, The troubling face of Cyprus: from a sheltered to a high-tech island? The place of innovation policy, J. Int. Relat. Dev. 5 (2002).
[24] K. Mueller, Innovation policy in the Czech Republic: from laissez faire to state activism, J. Int. Relat. Dev. 5 (2002).
[25] A. Havas, Does innovation policy matter in a transition country? The case of Hungary, J. Int. Relat. Dev. 5 (2002).
[26] P. Intarakumnerd, P.-a. Chairatana, T. Tangchitpiboon, National innovation systems in less successful developing countries: the case of Thailand, Res. Policy 31 (2002).
[27] B. Hotz-Hart, B. Good, C. Kuechler, A. Reuter-Hofer, Innovation Schweiz: Herausforderungen fuer Wirtschaft und Politik, Rueggi Verlag, Zuerich, 2003.
[28] L. Gokhberg, Russia's national innovation system and the "new economy", Probl. Econ. Transit. 46 (2004) 8–34.
[29] G. Parayil, From "Silicon Island" to "Biopolis of Asia": innovation policy and shifting competitive strategy in Singapore, Calif. Manag. Rev. 47 (2005).
[30] P. Oinas, Finland: a success story? Eur. Plann. Stud. 13 (2005).
[31] G. Rooks, L. Oerlemans, South Africa: a rising star? Assessing the X-effectiveness of South Africa's national system of innovation, Eur. Plann. Stud. 13 (2005).
[32] J. Bagherinejad, Cultivating technological innovations in Middle Eastern countries — factors affecting firms innovation behaviour in Iran, Cross Cult. Manag. 13 (2006) 361–380.

[33] L.J. Na, G. Ofori, M. Park, Stimulating construction innovation in Singapore through the national system of innovation, J. Constr. Eng. Manag. 132 (10) (October 2006) 1069–1082.
[34] M. Balzat, A. Pyka, Mapping national innovation systems in the OECD area, Int. J. Technol. Glob. 2 (2006).
[35] J. Groenewegen, M. van der Steen, The evolution of national innovation systems, J. Econ. Issues XL (2006).
[36] M. Berger, J. Revilla Diez, Can host innovation systems in late industrializing countries benefit from the presence of transnational corporations? Insights from Thailand's manufacturing industry, Eur. Plann. Stud. 16 (2008).
[37] J.S. Jauhiainen, Regional and innovation policies in Finland — towards convergence and/or mismatch? Reg. Stud. 42 (2008) 1031–1045.
[38] X. Ding, J. Li, J. Wang, In pursuit of technological innovation — China's science and technology policies and financial and fiscal incentives, J. Small Bus. Enterp. Dev. 15 (2008).
[39] K. Motohashi, Growing R&D collaboration of Japanese firms and policy implications for reforming the national innovation system, Asia Pac. Bus. Rev. 14 (2008) 339–361.
[40] K. Jackson, P. Debroux, Innovation in Japan: an introduction, Asia Pac. Bus. Rev. 14 (2008) 285–291.
[41] A.A. Kayal, National innovation systems a proposed framework for developing countries, Int. J. Entrep. Innov. Manag. 8 (2008).
[42] L. Jaaniste, State of the arts and innovation: before and after the review of the national innovation system, Aus. J. Public Adm. 68 (2009).
[43] M. Dodgson, Asia's national innovation system: institutional adaptability and rigidity in the face of global innovation challenges, Asia Pac. J. Manag. 26 (2009).
[44] B. Godin, National innovation system: the systems approach in historical perspective, Sci. Technol. Hum. Values 34 (2009).
[45] E. Webster, Does Australia have a 'national innovation system'? Aust. Econ. Rev. 42 (2009).
[46] J.-H. Eun, K. Lee, An empirical inquiry into "academy-run enterprises" in China: unique characteristics and evolutionary changes, Int. J. Innov. Manag. 14 (2010) 123–150.
[47] T.-W. Pan, S.-W. Hung, W.-M. Lu, DEA performance measurement of the national innovation system in Asia and Europe, Asia Pac. J. Oper. Res. 27 (2010) 369–392.
[48] W.H.A. Johnson, M. Chuang, A comparative innovation study of China, Japan and Taiwan, Chin. Manag. Stud. 4 (2010) 385–400.
[49] C. Watanabe, S. Akaike, J.-H. Shin, Adaptive efficiency of Japan's national innovation system towards a service oriented economy, J. Serv. Res. 10 (2010).
[50] I. Alvarez, R. Marin, Entry modes and national systems of innovation, J. Int. Manag. 16 (2010).
[51] A.O. Sakarya, Institutions' and initiatives' role in Turkey's national innovation system, Int. Bus. Econ. Res. J. 10 (2011).
[52] P. Intarakumnerd, C. Chaminade, Innovation policies in Thailand: towards a system of innovation approach? Asia Pac. Bus. Rev. 17 (2011) 241–256.
[53] J. Svarc, Does Croatian national innovation system (NIS) follow the path towards knowledge economy? Int. J. Technol. Transf. Commer. 10 (2011).
[54] A. Filipetti, D. Archibugi, Innovation in times of crises: national systems of innovation, structure, and demand, Res. Policy 40 (2011).
[55] R. Schnell, P. Hill, E. Esser, Methoden der empirischen Sozialforschung, 8 ed. Oldenburg Verlag, München, 2008.
[56] M.E. Porter, Competitive Advantage of Nations, Free Press, New York, 1990.
[57] M.E. Porter, Innovative capacity, In: in: M.E. Porter (Ed.), The Competitive Advantage of Nations, Boston, 2009.
[58] Kommission fuer Technologie und Innovation, Jahresbericht Foerderagentur fuer Innovation KTI, 2009. (Bern).
[59] M. Inganäs, Organizing and Managing University–industry Knowledge Transfer — A Study of the Swiss Biotechnology Sector, ETH, Zürich, 2008.
[60] Worldbank, Country Data Switzerland, 2011.
[61] B.A. Lundvall, Higher Education, Innovation and Economic Development, 2007.
[62] Bundesamt fuer Statistik, F+E Statistik, 2006.
[63] Bundesamt fuer Statistik, Indikatoren Wissenschaft und Technologie — F+E der Schweiz 2004, Finanzen und Personal, 2006.
[64] Eurostat, In: in: O.f.O.P.o.t.E. Communities (Ed.), Science, Technology and Innovation in Europe, 2008, (Luxembourg).
[65] Staatssekretariat fuer Wirtschaft — SECO, Die Regionalpolitik des Bundes, 2011.
[66] C.Marxt, C.Brunner, Innovationssystem Schweiz — Eine Bestandsaufnahme, 2009.
[67] Deutsches Institut fuer Wirtschaftsforschung e.V., Innovationsindikator Deutschland, 2008.
[68] C.Marxt, S.Nigsch, Neun Empfehlungen zur Förderung der Innovation in der Schweiz, Schweizer Wissenschafts- und Technologierat (SWTR), 2009.
[69] In: Der Schweizerische Bundesrat (Ed.), Der Schweizerische Bundesrat, Verordnung zum Forschungsgesetz, Der Schweizerische Bundesrat, 24.11.2010.
[70] Eidgenoessisches Volkwirtschaftsdepartement EVD, Innovationsfoerderung: 100-Millionen-Kredit schon ueberbucht, 2011.

Christian Marxt holds both the Chair of Technology Entrepreneurship at the University of Liechtenstein and works at ETH Zurich. In 2006 he worked as visiting researcher at UNSW in Sydney and in 2007 as visiting professor at Stanford University in the area of precision innovation and early rapid prototyping. He is interested in the strategic management of technology-oriented enterprises. He focuses on strategies of collaborative innovation and on technology transfer between university and industry, as well as science and technology policy. He is reviewer for several international journals.

Claudia Brunner is a PhD candidate, scientific researcher and lecturer at the University of Liechtenstein. Before becoming a PhD student, she studied business and philosophy at the Ludwig-Maximilians-University and at the University of Philosophy in Munich, Germany. She was awarded to participate at the 4th Lindau Meeting in Economic Sciences in 2011. Her research interests lie at the intersection of innovations management and nongovernmental or non-profit organizations.