



**Seven principles  
of success:  
The story behind  
Swiss innovation**

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“Innovation is not the product of logical thought, although the result is tied to logical structure.”

(Albert Einstein, 1897–1955)

## Innovation does not come at the flick of a switch

When it comes to enhancing social prosperity, there is no factor more important than innovation. Yet generating or promoting innovation at the political or regulatory level is by no means an easy task. On the one hand, very little is known about the processes behind successful innovation: how ideas are developed, how ideas can be turned into useful products and how these products can be successfully brought onto the market. And on the other hand, because innovation is often difficult to categorise and grasp, it can quickly fall prey to political arbitrariness and opportunism.

Broadly speaking we can describe every political move that sets out to improve the country's economic situation as an act of innovation policy. In recent years, practically all developed economies have declared innovation to be a priority in their growth policy, and this has given rise to an abundance of political programmes. Especially during economic boom periods politicians are likely to promise huge sums of money for research facilities and projects – the first few years of the 21st century are a case in point. In the meantime, however, many countries have run into such financial difficulty that they find themselves forced to put a stop to research projects and cut expenditure on education so that they can consolidate their national budgets. The problem is that research requires a certain degree of constancy, and this means that state and private-sector commitments should not be allowed to depend on economic cycles.

Strengthening economic conditions is always an act of innovation policy.

# Seven principles of success:

Against this backdrop we have to ask ourselves what can be done in order to maintain or improve innovative capacity in a global context. There are plenty of possibilities, but not every measure leads to success, and in some cases they can be counterproductive. Innovation cannot be equated with a specific solution technology, nor can it be ordered ready-made from a catalogue.

As an Alpine country without mineral resources, Switzerland relies heavily on innovation.

With a per capita gross domestic product of around 80,000 US dollars, an unemployment rate of 3.5 percent and a government debt ratio of 35 percent, the Swiss economy is currently on very solid ground. Innovation and know-how form the foundation stone of this prosperity, since as a small country without its own natural resources, Switzerland has always had to rely on a wealth of ideas and on openness. In Switzerland, achievement and inventiveness have always been very highly valued, and this is a tradition that is still very much alive today, as we can see from various comparisons at the European and international levels. But what are the building blocks of Switzerland's present-day success? Below we will endeavour to identify the most important factors based on the "seven principles of success". Most of these factors are long-term in nature and do not evolve overnight.

## Embracing the concept of "creative destruction"

Innovation is characterised by the culture, mentality and attitudes of people in a given society and, politically speaking, changing these "soft" factors is not an easy task. In addition, being open to new developments requires courage. Changes can only come into being if we are prepared to leave old habits and customs behind us. The frequently cited concept of "creative destruction" expresses this very appropriately. The seven principles of success form the framework that needs to be established through political acumen in order to encourage innovative and creative behaviour so that mankind can continue to evolve, or, in other words, an environment that is ready to embrace "creative destruction".

The right political framework encourages people to be innovative.

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Strengthen competitiveness

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Promote mathematics and science

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Politics: friend and foe of innovation

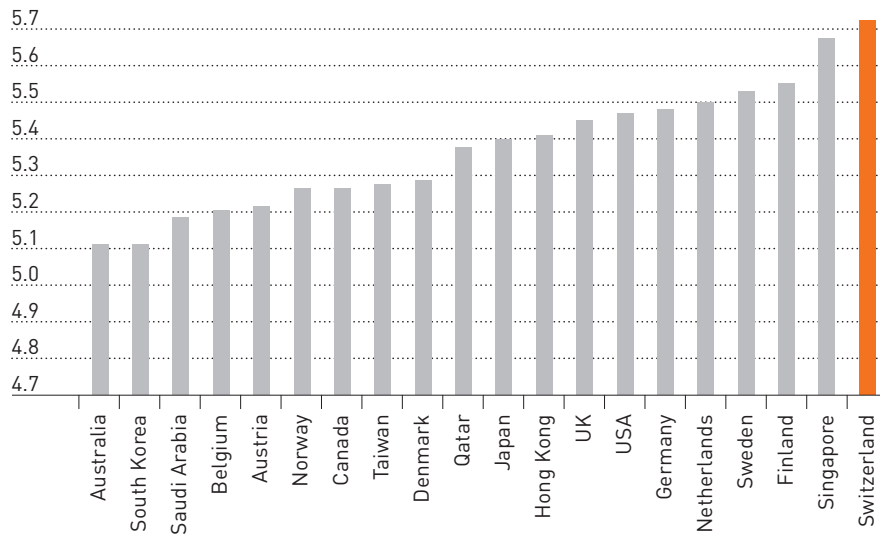
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# Principle 1: Strengthen competitiveness

When we speak of innovation policy, we are simultaneously talking about competition and location policy. These are virtually inseparable. To borrow the words of Schumpeter, “creative entrepreneurs” have to be able to spread their wings. Political over-activism has to be challenged and, in the event of state intervention, it always has to be viewed with caution – which is one of the reasons why, when it comes to competitiveness, countries like Switzerland, Singapore, Sweden, Finland and Germany are in a strong position today by global comparison.

**Competitiveness: Top 20 countries in the world (2012–2013)**

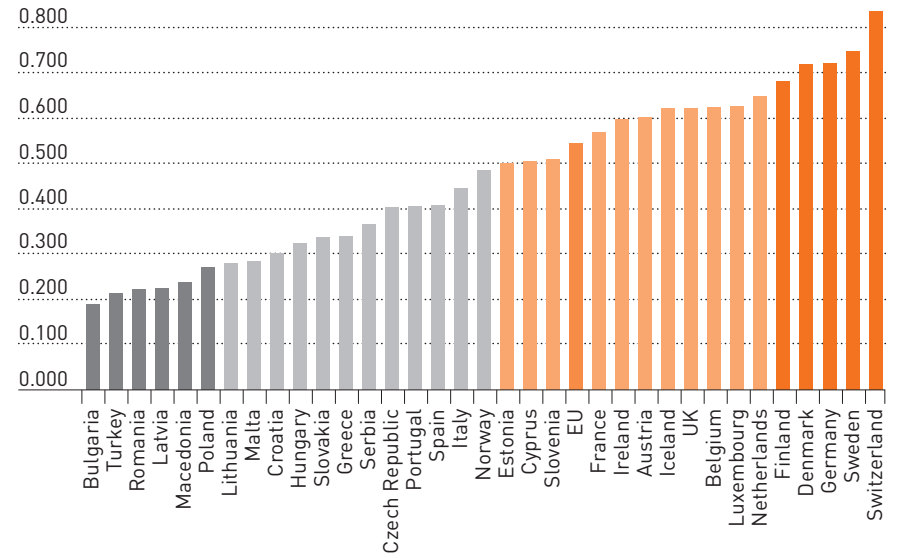


Source: WEF, Global Competitiveness Index 2012-2013

Competitiveness and innovation are inseparable.

It is interesting to note that it is usually the same countries that share the leading positions on innovation indices. Competitiveness and innovation go hand in hand. Paving the way for innovation therefore means above all promoting or intensifying competitiveness. The fact that Switzerland is currently faring so well on innovation indices can be attributed to a balanced policy which, in coordination with the business sector, creates scope for innovation and beneficial structural conditions.

**Innovation performance: international comparison**



Source: Innovation Union Scoreboard 2013

A policy that is oriented on classical regulatory criteria (free access to markets, private ownership of means of production, contractual freedom, principle of liability, constancy of economic policy) is the best means of promoting a country’s competitiveness.

Macroeconomic, political and legal stability plays a particularly important role here. Companies have to be able to count on a stable environment, otherwise they will not be willing to make long-term investments. In addition, a country’s standard of education has a major influence on its competitiveness. Companies need well-qualified personnel in order to be successful. Regulatory criteria should also not be underestimated. Here the rule of thumb is: the greater the degree of regulation (e.g. excessive protection against job dismissal), the lower the degree of competitiveness. A high level of state intervention in the market therefore has to be avoided. This also includes keeping the tax burden low. Tax privileges such as deductions for research and development expenditure can help keep the average tax burden low, although such measures may be assessed differently in terms of their effectiveness and administrative costs.

A high degree of regulation hampers competitiveness and thus reduces innovative capacity.

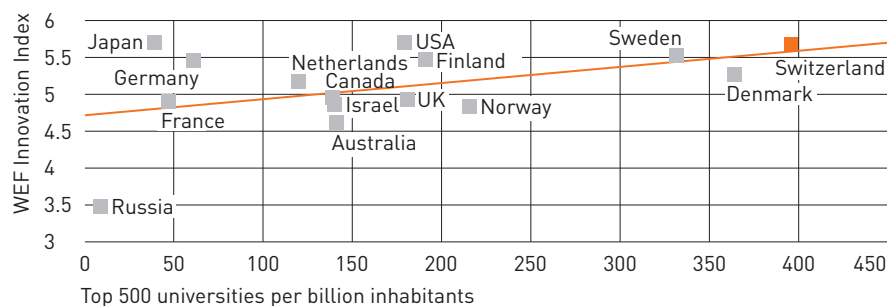
## Principle 2: Promote mathematics and science

People and their abilities are always the starting point of every innovation, but it is political, economic and social conditions that determine the extent to which people can develop and realise their abilities. Opportunities can only be of benefit if people can make the best possible use of them.

The level of education in society has to develop in line with technological progress.

Today, education is one of the most essential factors for securing technological progress and innovation, and in view of this it is important to ensure that the standard of education develops alongside technological progress. When it comes to generating research capacities, there is a fundamental interaction between education on the one hand, and research and development activities on the other. The availability of a sufficient number of highly-qualified and well-educated personnel is an essential prerequisite for ensuring the best possible use of public and private funding. If we view education in the context of innovation, the importance of excellence cannot be emphasised strongly enough. Innovators such as Larry Page and Sergei Brin (Stanford), Gordon Moore (Berkeley), Jeffrey Bezos (Princeton), Tim Berners-Lee (MIT, CERN), or Daniel Borel (Federal Institute of Technology, Lausanne) and Michael Näf (Federal Institute of Technology, Zurich) are just a small selection of creative figures who in the past few years have changed the world through commercialised ideas.

Countries with a Top 500 university in relation to their level of innovation



Sources: WEF 2011 [based on "Efficiency Enhancers" sub-index]; Shanghai Ranking 2011

One thing they have in common is the fact that they all studied at the world's leading universities. One of the most important roles of these universities is to bring together some of the best minds in the world. With its elite universities, the USA in particular has a strong international signal effect that is also reflected in its economic performance.

Switzerland has the world's highest density of Top 500 universities in per capita terms. Switzerland's education system may be very well positioned in an international comparison, but its lead over other countries is very tenuous. It is an unfortunate fact that, at the secondary education level, the importance of the "STEM" subjects (science, technology, engineering, mathematics) has declined in recent years. In secondary school curricula, less importance is being attached to the sciences, especially versus languages and humanities. And the number of STEM students at universities and colleges of technology has also declined in comparison with the number of students of humanities and social sciences. From an innovation policy point of view, this trend is extremely problematic. A sufficiently large pool of people with qualifications in the STEM subjects is absolutely essential for maintaining the country's innovative strength and for securing technological progress in the future.

A trend turnaround is therefore urgently required. What is called for is a higher degree of investment in the teaching of the STEM subjects, whether in the form of more effective teacher training or by enhancing the attractiveness of the corresponding teaching professions. The weighting of these subjects in schools also has to be adapted, since it is only in this way that the necessary degree of acceptance can be established and the corresponding scientific professions can be firmly anchored in society. An interest in and understanding of technology and the sciences needs to be awakened at an early stage, particularly because the STEM subjects are widely perceived to be more rigorous and demanding than the humanities and social sciences. In today's school curricula, language skills have become considerably more important for scholastic progress than the sciences, and here it is necessary to at least restore the balance between the two.

Interest in science and technology needs to be awakened at an early age.

## Principle 3: Promote a dual education system

International excellence is only one side of a good education system. If we examine the CVs of successful entrepreneurs, one thing quickly becomes apparent: in the course of their education they display a tendency to acquire a broad range of skills and capabilities. This behaviour corresponds to Lazear's "Jack of All Trades" theory of entrepreneurship, which is based on the assumption that (potential) entrepreneurs favour a balanced, broad-based education, whereas those intending to enter gainful employment tend to focus more strongly on a specific area of education. Economists subjected this theory to an empirical examination for Switzerland: their findings confirm the hypothesis that entrepreneurs prefer a combination of vocational and academic education, while by contrast, employees tend to opt for the one or the other because in this way they can acquire greater specialised skills rather than a broad-based education. In their conclusions, the authors of the study propose that switching between courses should be made easier in Switzerland so that young people can receive a broader-based (or more mixed) education.

The structure of the education system is clearly of relevance to the structure of the economy.

If we take a look at the dual education system in Switzerland we can see that, thanks in particular to the fact that it is simpler to pursue tertiary education after completing an apprenticeship, broad-based education is more widespread in Switzerland than in other countries. The proportion of entrepreneurs in Switzerland is significantly higher than in most other European countries, and this is a clear reflection of the fact that the structure of the education system is of relevance to the structure of the economy as well as the composition of its companies.

It is a fact that entrepreneurs need to have roots in both professional and business life. They can only envisage good business opportunities if they are familiar with the market and are aware of the specific needs of consumers. They also need to possess the necessary practical skills. Here, in order for young people to intensify the skills that are required for entrepreneurship, the opportunity to study at a higher level after completing an apprenticeship is a decisive factor. If we take a look at the present-day labour market in Switzerland, we can see that companies clearly give preference to students who have just completed their studies at colleges of technology over those who have just finished their university studies. The most likely

reason for this is that, during an apprenticeship, practice-related skills are passed on which in many professions are required in order for academic know-how to be put to use at all. It is therefore clear that it is not only excellent education which above all results in the acquisition of deep-seated expertise that is decisive for innovation. Transferability and practical relevance are also decisive components for ensuring that young people are able to fully utilise their capabilities.

### Academic education is not the only path to success

Today, there is a strong tendency in Switzerland to prefer to obtain better qualifications at school rather than start an apprenticeship, and this trend is expected to strengthen in the next few years. It is also very much in line with the ongoing international trend resulting in a constantly increasing proportion of holders of university degrees. This development has been welcomed by various organisations, including the OECD, which is pushing for as high a proportion of university graduates as possible, and has criticised Switzerland on a number of occasions for its still relatively low proportion in comparison with other countries. A variety of educational policy moves have been initiated in Switzerland with the aim of meeting the OECD recommendations. At first glance, the idea behind these moves seems sound: the more knowledge a society accumulates, the more innovative it will become. But from the point of view of innovation policy, this is not something that should be strived for. On the contrary: while excellence in university education is of central importance, a general "academisation" of education would significantly weaken Switzerland's innovative strength. In terms of its nature and structure, the existing dual education system is probably unique in the world and is a central success factor. But increasing the transferability of the different forms of education and rendering the various systems more compatible with one another is the most crucial factor. An apprenticeship followed by education at a college of technology cannot and should not be a substitute for university education. These two systems have to be regarded as complementary to, not as substitutes for, one another.

Excessive "academisation" of vocational training does not foster innovative capacity.

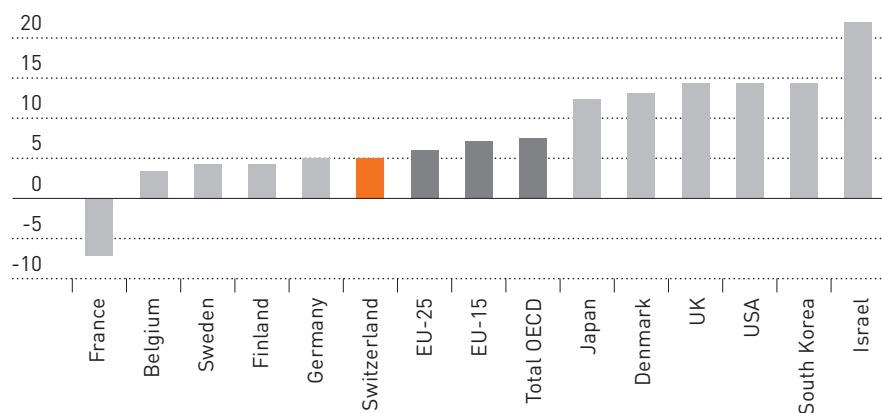
# Principle 4: Provide funding for research

Consistent with a strategic orientation towards innovation, in the past few years a variety of countries have intensified their efforts to promote research and development. Following the signing of the EU's Lisbon Strategy in 2000, European heads of state and government introduced a programme to promote innovative and competitive capacity. A variety of Asian states, as well as the BRICS countries, also redefined their priorities. In February 2006, for example, China announced the introduction of its new innovation strategy aimed at promoting the development of science and technology up to 2020, with a strong emphasis on enhancing the country's innovative capacity. The proportion of expenditure on research and development is to reach 2.5 percent of GDP by 2020. During the same period, the aim is to greatly increase the capacity of the Chinese university system in order to promote the development of elite universities.

The trend towards shifting research facilities to Asia represents a long-term threat to Switzerland as a centre of innovation.

Today there is a clear trend towards shifting research facilities to Asia. Around three-quarters of all research and development locations to be developed in the future are either in China or India. As a result of this trend it is to be feared that Switzerland's strong position in the area of innovation and research could be eroded over the long term. For example, the growth rates for gross expenditure on research and development in the private sector in the period from 2004 to 2008 indicate only average increases for Switzerland.

**Expenditure on research and development by the private sector in an international comparison: change in percentage of GDP between 2004 and 2008**



Sources: OECD, MSTI database, STI/EAS, Paris, November 2009; Swiss Federal Statistical Office, Research and Development Statistics

For Israel, which is currently at the top of the table, the equivalent figure is around four times higher. In the USA and South Korea, too, the growth rates are around three times higher than those in Switzerland.

Other data, e.g. the readings on the European Scoreboard, which now also only places Switzerland in midfield, confirm this picture. Furthermore, even Swiss companies are investing outside the country to an increasing extent and benefiting from the increasingly attractive conditions available elsewhere. At the end of the 1980s, Switzerland was more attractive for domestic companies as a research location, but this situation began to reverse during the 1990s. By 2008, Swiss companies were already investing around 25 percent more outside the country than at home.

## Expenditure on education and research must be a priority

Here, countermeasures are urgently required. As a small country with a high degree of know-how but without its own natural resources, Switzerland relies on a sufficient (and in an international comparison, a disproportionately high) level of investment in research and development. Both the private sector and the state have to confront this challenge. Expenditure for research and development needs to be prioritised and significantly increased. But this does not mean shifting the weight of responsibility from the private sector to the state. On the contrary: the fact that a very high proportion of investments in research and development is financed via the private sector is one of Switzerland's main strengths. The contribution from the state (most notably towards basic research) forms the foundation on which the private sector can build. In view of the lengthy period of time that is required between state expenditure on education and research and the development of innovation, a policy with a long-term horizon is called for. Since most research projects tend to last for a number of years, universities need to be able to plan on a longer-term basis. A "stop and go" policy for state expenditure on education and research renders this much more difficult, if not impossible. Since the results of research are by nature open, there is never a guarantee that any given state expenditure will at some time in the future lead to successful innovation.

The fact that a large proportion of research expenditure comes from the private sector is one of Switzerland's strengths.



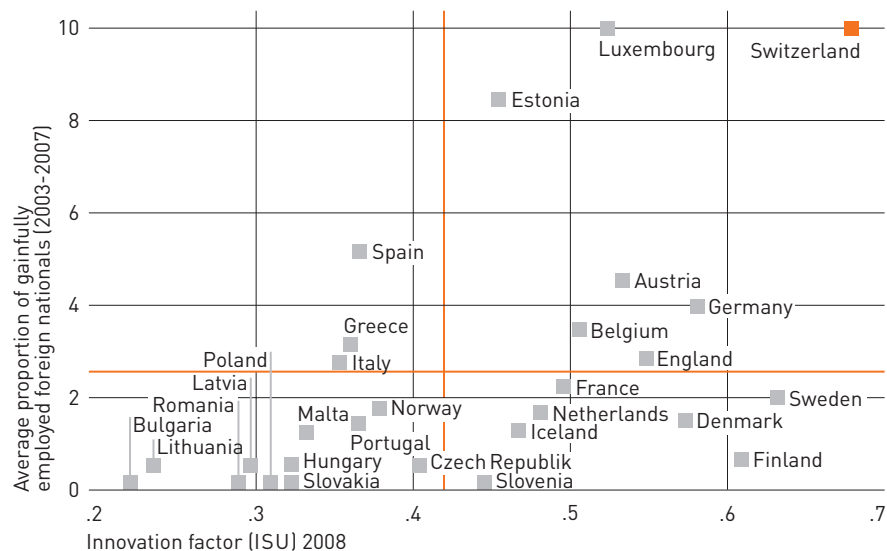
# Principle 5: Maintain open markets

The innovative capacity of foreign nationals and foreign companies in Switzerland has always been enormous and has a lengthy tradition. People like Henri Nestlé (Nestlé), Walter Boveri (ABB), Xavier Givaudan (Givaudan), Anton Rupert (Richemont) and Nicolas Hayek (Swatch Group) have all made major contributions towards the prosperity Switzerland enjoys today. Many of the leading companies active in Switzerland today either evolved from foreign companies or were originally established abroad. Switzerland's attractiveness has persisted until today and is underscored through the fact that more than 30 international organisations chose Switzerland as the location for their headquarters.

Stable conditions and a high quality of life support the "brain gain" from which Switzerland is currently benefiting.

While low tax rates were until recently the main argument for the choice of location, nowadays other factors are gaining in importance, for example quality of life and stable political and legal conditions. Here Switzerland is in a strong position and is therefore able to attract foreign companies and highly qualified personnel. In recent years this resulted in an enormous "brain gain", without which Switzerland would not have been able to attain its leading international position.

**Correlation between innovation and the proportion of gainfully employed foreign nationals**



Source: European Scoreboard

As the above diagram shows, the innovative strength of a country tends to increase when it has a large number of foreign personnel. However, it is difficult to demonstrate a causal link, because prosperous and innovative countries are in any case attractive, especially for immigrants. In addition, as a consequence of the higher growth potential in prosperous countries, there is always a greater demand for personnel who, in a small country like Switzerland, cannot be recruited on the domestic labour market.

Recent studies concerning the USA clearly demonstrate the positive influence of a balanced immigration policy on a country's economic growth and development. The two most important factors are the motives and educational level of immigrants. In other words, selection is absolutely decisive. According to economist Jennifer Hunt, for example, it is mainly young, well-qualified immigrants who as students or highly qualified employees are able to create a high level of added value in an economy over the medium to long term, and they are also more active when it comes to setting up companies. They also register around twice as many patents (in the USA) as locals. This already takes the fact into account that they possess very high qualifications in the areas of science and technology. Graduates studying for a masters degree or doctorate are the most "lucrative" group, and should therefore be specifically targeted and supported.

A balanced immigration policy can positively influence a country's economic growth.

The facilitation of recruitment of foreign personnel for the Swiss labour market has been a highly contentious issue in the past, and remains so today. In the 1960s, 1970s and 1980s, large numbers of immigrants who were relatively poorly qualified settled in Switzerland, but in the past decade or so, the focus of immigration policy has shifted in favour of highly qualified personnel. Although it is still too early to draw any concrete conclusions from this change in policy, one thing has already become clear, namely that the employees who are recruited today, mostly from neighbouring countries, not only become integrated into society much more smoothly, but also create jobs for Swiss citizens and contribute towards an increase in economic productivity. Although this new wave of immigration has also given rise to a variety of negative "side effects", the net benefit is fundamentally positive, even when the resulting social expenditure is taken into account.

The influx of highly-qualified personnel from abroad has created jobs in Switzerland for the local population as well.



# Principle 6: Promote international networking

It is widely agreed that start-ups and small and medium-sized companies are important drivers of innovation, but the major role played by multinationals in the areas of innovation and progress is often overlooked. Yet these companies are usually the dominating factor for economic growth. Thanks to their excellent global networks (with other public and/or private-sector research institutions) and their international recruiting and distribution capacities, they form a genuine focal point of innovation.

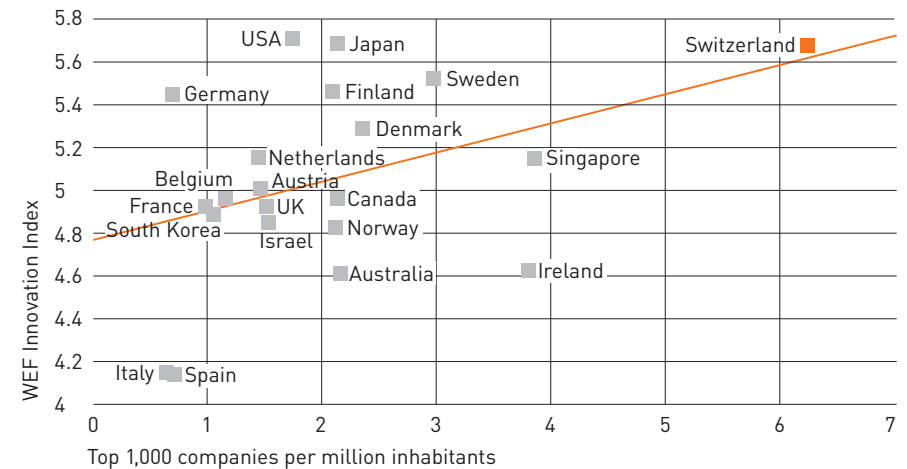
The presence of large export-oriented companies is crucial for growth and innovation in Switzerland.

The importance of multinationals for a country's innovative capacity was examined in a study called "Creative Switzerland?" that was conducted in 2008 by the Boston Consulting Group. Under the heading, "The Pillars of Wealth", the main drivers of innovation and growth in the Swiss economy were identified and listed. These primarily concern large export-oriented industrial and services groups which help drive the economy thanks to their productivity and their creation of new jobs. These companies account for around 35 percent of Switzerland's gross domestic product, and, in terms of turnover, their average growth rate in the period from 1997 to 2006 was almost twice that of other companies. They also generated a 74 percent higher value added per employee and created more than 140,000 jobs.

## International activity as a driver of innovation

In major companies, international networking is one of the main driving forces behind innovative capacity, and the same could be said for the economy as a whole. In this way, Switzerland is able to offset to some extent the disadvantages it has to overcome as a small country. Know-how and ideas do not stop at national borders, and innovative processes are not limited to individual sectors.

Correlation between multinationals and innovation



Source: Forbes (listing of 2,000 biggest companies by turnover)

Private-sector networks cannot be called for at the political level, but it is possible for the state to eliminate cross-border obstacles and create incentives. It would be possible, for example, to tie government research funding to joint ventures to a greater extent. It is also essential to secure greater access for Switzerland to the international research community by concluding bilateral research agreements or joining research networks. Especially large scientific projects such as CERN in Geneva or the Human Brain Project at the Federal Institute of Technology in Lausanne are based on the participation of researchers from all over the world.

Thanks to networking, Switzerland is able to largely offset the disadvantages due to its size.

## Principle 7: Pursue a policy of creating freedom of action

Many governments set out to pursue as active an innovation policy as possible, i.e. to put a theoretically functional innovation into practice. Here, a term that is frequently encountered today is “general purpose technology”. This refers to technologies that characterise an entire national economy and have the potential to fundamentally change the whole of society – or several societies. Whether consciously or otherwise, the term is politically instrumentalised and frequently misunderstood. But a successful innovation policy does not mean that political planners should invest at their own discretion in what are perceived as “hot areas” of private technology. In most cases, this gives rise to costly and inefficient developments.

Dynamic innovation processes cannot be predetermined or planned on the drawing board.

Hot areas are the result of dynamic processes that are difficult or even impossible to assess. And innovations are also highly sensitive. Both these factors lead to major uncertainty and to potential outcomes that are socially inefficient and counterproductive if the processes are planned in a centralised manner on the drawing board. But this is something that is mostly overlooked. For many politicians, the notion of being able to guide society single-handedly as a kind of visionary or leading light towards a “new future” appears to be too tempting.

The fact that organisations that have been created with the aid of subsidies cannot simply be abolished at a later date is also something that is frequently forgotten. Institutions are usually less dynamic than the goals they are supposed to achieve or the development of the market economy. Paradoxically, once the original objectives have been met or the declared goal is no longer socially desirable, a large portion of the subsidies are then consumed in the redistribution struggle – to the detriment of the organisations concerned. Another decisive mistake that politicians repeatedly make (consciously) in connection with the promotion of innovation is that they attempt to achieve several goals with a single instrument. For example, in the case of green energy this concerns not only innovation promotion and market leadership in this “future technology”, but also protection of the environment and increasing the employment rate. In the ongoing debate in Switzerland on “ecological tax reform”, too, the term “double dividend” is frequently being applied.

The fact that an economic policy instrument should always only be used to achieve a single goal has been clearly demonstrated by economist Jan Tinbergen. If an instrument is used to meet more than one goal, in the end none of the goals will be fully achieved. One of the reasons for this is that conflicts of interests can arise. In the area of environmental protection, for example, many measures have a negative impact on growth and thus on employment, but this does not mean that these measures should not be implemented. Here it is necessary to weigh up the social costs against the resulting benefits. But those who are not aware of such potential conflicts of interest may find that really what all their big promises ultimately yield is a large amount of costs.

Politicians are often tempted to try to achieve a number of objectives with the aid of a single instrument.

### Enabling people to fully realise their potential

A sound innovation policy primarily creates freedom of action. It is not the policy itself that can create innovation or assess it. Instead, it is the potential of people within the research institutions and companies that has to be promoted through carefully considered regulations and guidelines. If the basic conditions are not right, innovation cannot be achieved. Here is an example to illustrate this: For a number of years now, Switzerland and Europe as a whole have been faced with the problem that many companies outsource their production to cheaper locations. The main reason for this decision is increased pressure on prices. But this is a dangerous trend for every innovation and research location, since there is often an underestimated correlation between research and production. Research processes and production procedures cannot be readily separated, since in many cases they are highly interrelated. If the production platform is not present at the research location, sooner or later the research side will also be transferred. Instead of endeavouring to realise their own visions, politicians should therefore create the necessary conditions for companies and research institutions to be creative and productive over the long term. A genuine innovation policy therefore calls for a broad view and has to encompass all realities. An innovation policy with too narrow a focus restricts innovation.

Research and production closely interact with one another and therefore cannot be completely separated.

# Politics: friend and foe of innovation

Politics is both the friend and the foe of innovation. With a sound innovation policy the basis can be created for long-term prosperity and growth, while a weak innovation policy causes high costs without yielding any benefits, or it may even harm the economy.

A sound innovation policy has to be “blind”: it should not claim to already know today what will be successful tomorrow.

While many political ideas appear at first glance to promote innovation, a closer look reveals them to be counterproductive. In a certain sense, a sound innovation policy therefore needs to be “blind”: it should not be based on the illusion that we already know today what the technologies of the future will be. This lack of specific knowledge makes it difficult to “sell” a sound innovation policy in the political process. We want to solve today’s problems quickly and comprehensively. Instead, the objectives need to be more modest and defined over the long term: in a process in which the outcome is open-ended, principles have to be formulated that make it possible to solve major problems in the future with a certain degree of probability.

## A puzzle with many pieces

The period of time that is required from initial investment in education and research through to the introduction of a new product can be very lengthy, and the possibility of failure is also an inherent element of every innovation process. Such processes never develop in a linear manner or in accordance with a predictable pattern. There is neither a clear differentiation of roles between universities, colleges of technology and the private sector, nor is it feasible in practice to differentiate between basic research, applied research and specific market development. Instead, everything first has to be put together like the pieces of a puzzle. The state is able to optimise some of these pieces and then must hope that someone else contributes additional pieces and puts them together correctly so that an idea or an overall picture emerges. It is only this picture that represents an innovation that offers value added. In the innovation process, confidence therefore has to be placed in the smooth functioning of the market economy.

It is also important to recognise that many measures have an indirect effect on a country’s innovative capacity by influencing its competitiveness. For example, a country’s tax system and tax rates influence its competitiveness and therefore also have an effect on its innovative capacity, if only indirectly.

## Locational competition is an incentive, not a threat

The seven principles for a successful innovation policy presented in this document based on the example of Switzerland are intended to serve as a rough guideline for day-to-day political life. While some of the proposals are very specific, others have been deliberately formulated in a more general manner. Competitors from countries outside Europe, in particular emerging economies such as China and Brazil, are learning very quickly. But rather than perceiving this as a threat, we should regard it as an opportunity to benefit from one another, and as an incentive to develop and pursue a sound innovation policy.

Principles of innovation policy: rough guidelines for day-to-day political life.

“The reasonable man adapts himself to the world; the unreasonable one persists in trying to adapt the world to himself. Therefore all progress depends on the unreasonable man.”

[George Bernard Shaw, 1856–1950]



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