Switzerland's digital innovation capacity
Good, but not good enough

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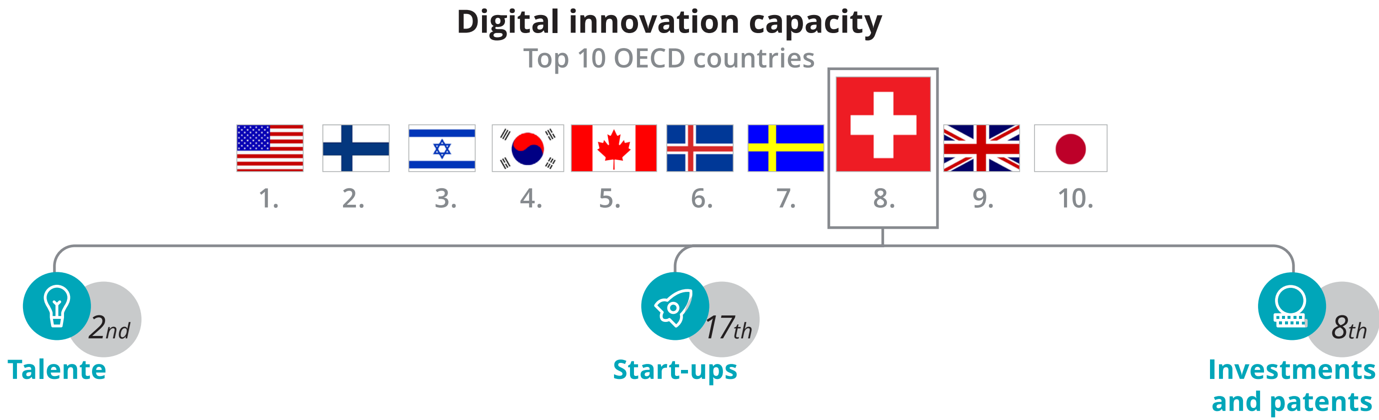
1. Key findings

Switzerland's digital innovation capacity: good, but not good enough

In terms of its digital innovation capacity, Switzerland performs well in comparison to other OECD countries, ranking eighth out of the top ten countries. However, there is a relatively wide gap between it and the top performers, indicating plenty of room for improvement. Digital innovation capacity can be measured using three main pillars: talent; start-ups; and investments and patents.



Talent: a good education system and an attractive environment

Switzerland is among the top performers with regard to talent. With its excellent education system, world-class universities and attractiveness to foreign workers, it ranks second among the OECD countries. More graduates in MINT subjects and more teaching of digital competencies are needed, however.

Start-ups: little interest in starting a business, good infrastructure

Switzerland is a mid-range performer on this indicator, ranking 17th – scoring exactly the OECD average. The main reasons are a lack of interest in starting a business, relatively low start-up activity and regulatory obstacles both to setting up a business and to declaring insolvency. More positive factors include the country's digital infrastructure and the international orientation of start-ups.

Investments and patents: high levels of investment but little networking

Switzerland is among the top 10 OECD countries for investments and patents. Investment in ICT is very high, but the ICT sector creates little added value. The number of digital patents (per capita) is also relatively high by OECD standards, but these patents are not yet adequately penetrating other technologies.

What Switzerland needs to do

There is scope for Switzerland – government in particular but also business and business associations– to take action in each of the three main areas assessed by the Digital Innovation Capacity Index. Action in these areas would help improve Switzerland's performance and rankings.

Talent:
- Increasing the number of MINT students
- More teaching of digital and social skills
- Relaxing restrictions on recruitment from non-EU countries

Start-ups:
- Boosting awareness of entrepreneurship during education and training
- Dismantling regulatory obstacles, in particular to the processes for starting up a business and declaring insolvency
- Improving support for start-ups

Investments and patents:
- Promoting research and innovation by increasing tax relief for R&D
- Developing and improving e-government
- Improving networking between the education and private sectors

What companies need to do

The state's scope for intervention is limited mainly to creating a favourable framework for digital innovation, so companies have a major role to play. They have a crucial influence on the effective use of digital technologies. The greater the extent of digitalisation in companies, the greater the impact on productivity is likely to be. Companies should be considering the following critical success factors:

Strategy: developing a clear and coherent digital strategy

Talent management: promoting digital skills of employees

Corporate culture: developing enthusiasm for experimentation, collaboration and an appetite for risk part of the corporate culture

Corporate leadership: embedding digital skills at management level

2. The role of digital technologies in productivity growth

With high growth, low unemployment and excellent rankings for competitiveness, Switzerland's economy is performing extremely well in comparison to other industrialised countries. Its relative position has improved continuously since 2000; and this trend has accelerated following the global economic and financial crisis.

The only performance indicator inconsistent with this success story is per capita economic output – the average prosperity of the population. Since the economic and financial crisis, Switzerland's real per capita Gross Domestic Product (GDP) has not grown as rapidly as in other OECD countries, or the G7 economies.[1]

Falling productivity growth

Two factors determine growth in economic output: the total amount of labour and productivity. To increase per capita GDP, the Swiss population must therefore either work more hours or become more productive.

In recent years, there has been a sharp slowdown in labour productivity growth. Higher per capita GDP has been achieved mainly through an increase in hours worked, particularly as a result of population growth. In recent decades, labour productivity growth has slowed in other developed economies too, but as Chart 1 shows, Swiss productivity growth has fairly been less than in the US and other G7 economies.[2]

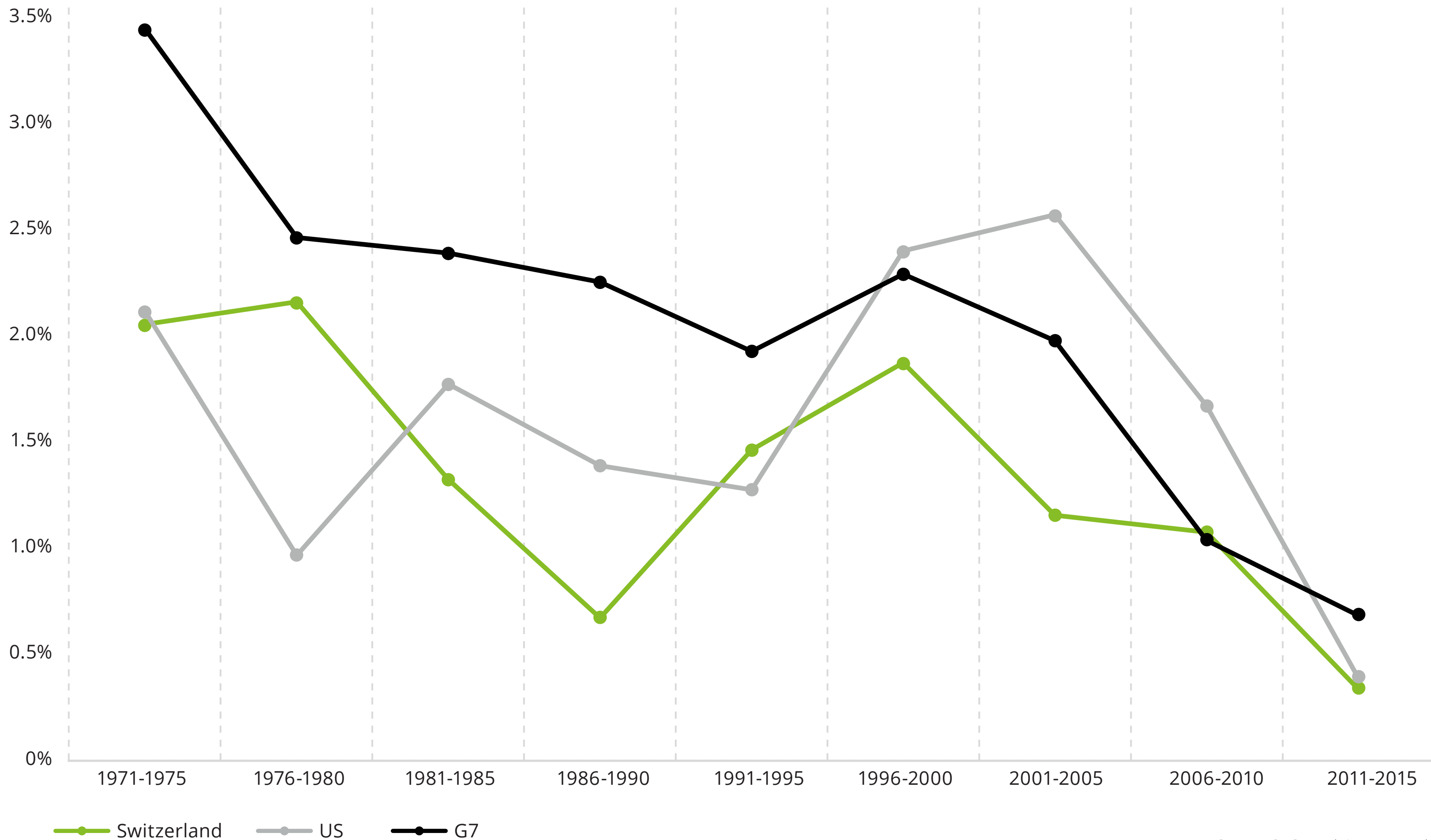
The decline in productivity growth began much earlier than the 1970s, however. Economist Robert Gordon has demonstrated, with reference to the US, that growth in productivity was at its highest between 1920 and 1970, at an average of 2.8 per cent a year.[3] By 2014, this had fallen to 1.6 per cent, only fractionally higher than the 1.5 per cent annual average growth recorded between 1890 and 1920.

Stagnating productivity growth is a cause for concern. Productivity is crucial for economic growth and underpins the long-term increase in per capita GDP since the volume of labour - the other determining factor of productivity growth - cannot be increased indefinitely. In fact, Switzerland even faces the possibility of no increase in the size of its work force in the near future. As a result of demographic change, and in particular the fact that the 'baby-boomer' generation is now reaching retirement age, a decrease in the working population as a proportion of the total population is imminent, and this will mean a fall in the total number of hours worked.* It cannot be assumed that this shortfall can be offset completely by recruiting migrant labour, so productivity will be the key to arresting the decline in Switzerland's per capita GDP growth rate.

* According to forecasts by the Swiss Federal Statistical Office, the employed population as a proportion of the total population is likely to fall from 58.4 per cent currently to 54.6 per cent by 2030

Chart 1. Growth in labour productivity

Five-year average growth



Source: OECD, Deloitte Research

Impact of digitalisation on productivity

A number of factors may contribute to increases in productivity, such as a more favourable business environment and a more highly skilled workforce. However, technological progress is the key factor. Since the first Industrial Revolution in the late 18th century, technological advances –such as the steam engine and electricity – have driven change and fuelled productivity growth in many sectors of the economy.

Gordon argues that the main reason for the decline in productivity growth has been a fall in the marginal utility of innovations. In his view, the volume, density and significance of ground-breaking discoveries made up to the 1970s are unlikely ever to be repeated. Passenger transport is a good example: developments in transport were revolutionary in the 100 years that separated the horse-drawn carriage and the maiden flight of the Boeing 707 in 1958, which came close to breaking the sound barrier. Since then, the speed of passenger transport has remained largely unchanged, despite decades of development work.

Over recent decades, technological progress has been based predominantly on information technology and digitalisation. As with the steam engine and electricity, this technology has transformed the structure of the economy, and there is a broad array of digital technologies available to businesses, ranging from simple computers to data analytics, artificial intelligence and robotics.

These technologies help to increase productivity in two ways: they support higher productivity in the technology and ICT sectors themselves; and they drive productivity growth in other sectors where businesses make use of digital technology. The impact on productivity is greatest where digital innovations are deployed right across the economy: manufacturing software is a good example.

Technological innovation does not have an instant effect on productivity, and it usually takes some time before its impact becomes evident. However, statistical methods may well be one reason for this: it takes time for statistical services to adapt and for official figures to reflect innovation. For example, it took decades for automotive vehicles to be included in the US price index.[4] There is likely to be a similar – though probably shorter – time lag before the impact of new technologies feeds through into official statistics.

It also takes time for new technologies to gain a foothold throughout the economy and have an impact on productivity. The reason for this is the learning curve and the organisational restructuring that is required when new technologies are introduced. This time lag may well explain why advances in digital technologies in recent years are not (yet) reflected in productivity figures. However, this is not the primary reason for the long-term decline in productivity growth: a time lag before trends are reflected in statistics is nothing new.[5]

Consumer versus corporate sector

What is new in recent years, however, is the narrower focus of digital innovation. In contrast to older technologies, developments in digital technologies are in sectors that are consumer-focused and place greater emphasis on promoting consumer comfort and convenience, rather than driving up companies' productivity.[6 7] Perhaps the best example is the rapid and ongoing development of smartphones. From a consumer perspective, smartphones are technologically impressive but also extremely practical, offering a combination of communications capacity, navigation tools and entertainment. Whereas innovation in digital communications has been rapid in consumer-focused businesses, the pace of change has been much slower in other businesses. Business people have been using mobile phones to access emails for ten years, and to make calls and send or receive text messages for 20 years. Today's smartphones may be thinner and easier to operate than older mobile phones, but that has made little difference to their business-related functions.

It is therefore all the more important that technological advances in the consumer-focused sectors should, where possible, be carried across to business-focused sectors, where they can help to accelerate productivity growth. For instance, consumer applications are improved continually to make their use easier and their interfaces more intuitive. In contrast, business-related applications often lag behind, taking up time and resources unnecessarily and hampering productivity. Any new business application must be intuitive to use, and will fail if users need training for it.

Untapped potential

Although digitalisation has been unable to reverse the decline in productivity growth across the economy over recent years, there can be no doubt that digital technologies represent the most significant opportunity to boost productivity growth and so achieve greater prosperity for the population.

First, there is substantial untapped potential within companies for making use of existing digital innovations that are currently consumer-focused. Second, technological progress will continue in many sub-disciplines of digitalisation, such as artificial intelligence and big data. Indeed, many experts assume that such progress is still in its infancy.

There is already evidence that digitalisation is having a positive impact on productivity, as reflected in the sharp acceleration in productivity growth in the 1990s and early 2000s (see Chart 1). The Swiss State Secretariat for Economic Affairs (SECO) believes that over the next few years, there is potential for digitalisation to generate further substantial growth.[8] Even if the country does not return to the 'golden age' of productivity growth, the trend could be reversed and growth could accelerate again. The key factor will be how well Switzerland is equipped to innovate and to develop and make use of digital technologies.

3. Switzerland's digital innovation capacity in a global context

3.1 The Digital Innovation Capacity Index

The Digital Innovation Capacity Index demonstrates how well Switzerland compares with other OECD countries in terms of developing and using digital technologies. The Index measures a country's capacity to develop, market and apply innovative digital technologies to achieve prosperity for its population in the long term. It is based on the digital competitiveness methodology devised by Deloitte Germany.[9]

Core components of innovativeness

As Chart 2 shows, digital innovation capacity is based on three core pillars: talent, start-ups, and investments and patents. Each pillar is given equal weighting for the purpose of ranking on the Index.

- **Talent:** this pillar measures the availability of talent within an economy. Digital technologies cannot be developed or used effectively without a critical mass of highly skilled IT experts. The key determining factors are not only current levels of talent, but also the quantity and specialisation of talent poised to come on stream over the next few years. Both the education systems and the attractiveness of a country are important here.

- **Start-ups:** this pillar measures the enthusiasm within the economy for entrepreneurship, and the level of entrepreneurial activity within that economy. Most digital innovation happens within start-ups, so entrepreneurship is the most important way of producing digital solutions for the market and commercialising them.

- **Investments and patents:** this pillar measures digital investments by companies in R&D and general investment in ICT, and the number of patents, along with digital penetration of the economy. Digital investments and patents are both key factors that enable a country to compete in terms of innovation, and are vital for its ability to make full use of the potential for digital technologies to increase productivity.

Overall, the Digital Innovation Capacity Index measures new innovation models within an economy. Highly skilled talent and human capital are prerequisites for digital innovation. Start-ups bring new ideas and trends to market, or make them available to major companies. Finally, investments and patents ensure that innovations are able to compete in the market and that their potential is fully exploited. These three pillars interact and mutually reinforce each other.

Chart 2. Make-up of the Digital Innovation Capacity Index

Digital Innovation Capacity

1/3 1/3 1/3

Talente

Pool
- Availability of scientists and engineers
- ICT specialists
- Availability of digitally skilled workers

Pipeline
- MINT students (share)
- Quality and number of technical universities
- Quality and number of IT faculties
- Quality of maths and science education

Appeal
- Capacity to retain talent
- Quality of life
- Reputation
- Capacity to attract talent

Start-ups

Entrepreneurship
- Entrepreneurship as good career option
- Perceived capabilities
- Perceived opportunities
- Fear of failure
- High status for successful entrepreneurs

Venture capital
- Early-stage venture capital
- Late-stage venture capital

Cost
- Cost of labour
- Tax burden

Regulation
- Communication and simplification of rules and procedures
- Administrative burdens for entrepreneurs
- Intellectual property protection

Market & Infrastructure
- Start-up activity
- Size of domestic market
- International orientation of start-ups
- ICT infrastructure (hardware)
- Online Service Index

Investments and patents

Investments
- ICT investments as % of GDP
- ICT sector as a proportion of total value added
- ICT sector‘s R&D expenditure as % of GDP
- ICT sector‘s R&D expenditure as % of total R&D expenditure

Patents
- Digital technologies: all patents (per capita)
- Digital technologies: world class patents (per capita)
- Digital penetration rate: all patents
- Digital penetration rate: world class patents

"Knowledge and innovation are the keys to the success of Switzerland – and ABB. The only way to stay successful is to keep attracting top talents, to further invest in R&D, to strive for constant improvement, and to develop and market innovative products for our customers. Inertia means setback; curiosity and the courage to take risk means progress."

Dr. René Cotting, Head of Operations, Innovation and R&D ABB Group

Switzerland performs relatively well

In comparison with other OECD countries, Switzerland performs well overall in terms of its digital innovation capacity, scoring 51 and ranking eighth in the table (see Chart 3, dark green column).

The points score reflects each individual country's relative performance. A score of 100 signifies that a country is the best performing OECD country for every indicator and a score of 0 that that it is the worst performer. The total score reflects the weighted average of all indicators belonging to the pillar. Each pillar contributes equally to a country's overall ranking (see Chart 2).

The US heads the league table, with a score 9 and 11 points above the next-ranked countries, Finland and Israel respectively. The other countries in the top ten are more closely grouped together, with Switzerland almost as many points behind Finland as Finland is behind the US.

Top of the talent table but weak on start-ups

Chart 3 shows the distribution of results for individual countries. On the left, the worst country in the ranking, on the right, the best. The green diamonds indicate the place of each country in the Index rankings; while the dark grey diamond is the OECD average.

Switzerland performs best for talent. With a score of 69, it ranks second and well above the average score of 44. The US has top ranking, with a score of 79.

Switzerland performs less well for investments and patents. With a score of 42, it significantly outperforms the average (30) but lies 28 points behind the leader, Israel.

The greatest potential for improvement can be seen in Switzerland's score for start-ups: this is 43, exactly the OECD average, and a significant 27 points behind the top-ranking US.

Chart 3. Top 20 ranking countries on the Index

Rank	Country	Index	Talente	Start-ups	Investments and patents
1	United States	67	79	70	51
2	Finland	58	67	46	61
3	Israel	55	50	46	70
4	South Korea	54	41	55	65
5	Canada	53	64	63	33
6	Iceland	52	50	52	53
7	Schweden	52	58	42	55
8	Switzerland	51	69	43	42
9	UK	48	63	52	27
10	Japan	48	49	46	48
11	Netherlands	46	56	48	34
12	New Zealand	45	47	59	30
13	Australia	45	51	49	33
14	Ireland	44	49	47	37
15	Germany	43	63	38	26
16	Estonia	42	36	52	37
17	Denmark	41	52	45	27
18	Norway	41	56	41	26
19	Austria	40	42	49	28
20	Belgium	37	47	33	30
	Ø		44	43	30

MIN → MAX

Note: the green diamond represents each individual country's score within an overall distribution. The grey diamond represents the average. The maximum points score is given on the right-hand end of the range with the minimum on the left.

"Education has a long-term effect, and improvements take a long time to work through. Changes to the education system also need to be planned carefully and over a long time scale."

Josef Widmer, Deputy Director of the Swiss State Secretariat for Education, Research and Innovation

3.2 Talent

The talent pillar analyses a country's current 'talent pool' of specialists in IT and MINT subjects (mathematics, informatics, natural sciences and technology), its future pool (the 'talent pipeline)' and its attractiveness to foreign workers.

With an Index score of 69, Switzerland performs very well overall, ranking second (see Chart 4). It is also among the top performers for many of the indicators.

The talent pool: plenty of ICT specialists but a shortage of ICT researchers

The current talent pool is assessed by means of three indicators that together form the basis for developing and making use of digital technologies.

For one of these indicators, the general availability of scientists and engineers, Switzerland performs relatively well, ranking eighth, although there is a fairly wide gap to the best-performing countries. This indicator is based on an annual survey of company managers conducted by the World Economic Forum (WEF). The gap between Switzerland and the top performers can be attributed mainly to the shortage of skilled engineers, technicians and health professionals.[10] Given the shortage of Swiss workers with the right skills, these occupations rely on recruiting foreign workers from non-EU countries, but recruitment from these countries is subject to strict quotas and often involves substantial bureaucracy.[11]

Switzerland performs better in terms of its talent pool of IT specialists. This pool is measured as a percentage of total employment and includes electrical and electronic engineers, IT service managers, IT technicians and IT professionals. These groups make up five per cent of all employment in Switzerland, which ranks fourth among OECD countries in the Index, with a score of 76.

The OECD also provides country-specific data on ICT researchers, as well as IT specialists. However, this measures ICT researchers only as a proportion of the total number of researchers. As Switzerland has traditionally specialised in pharmaceuticals and chemicals as well as mechanical engineering, ICT researchers make up just 14 per cent of the total of all researchers (though their absolute number is high), which places Switzerland towards the bottom of the rankings. However, since this relatively poor performance does not reflect the actual situation, it has been excluded from this Index.

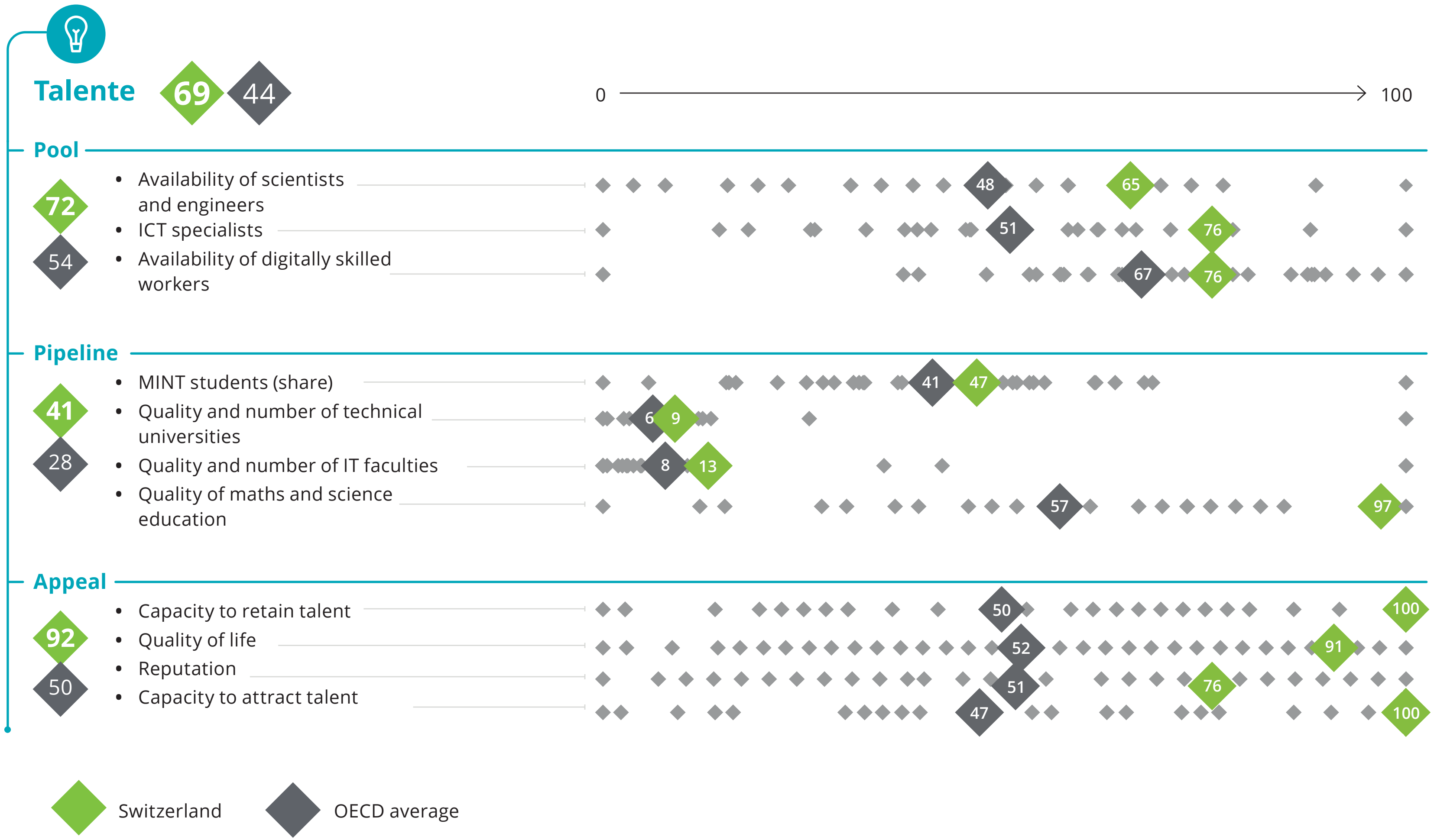
As digital technologies are multidisciplinary technologies, a country's talent pool should consist of not only of IT specialists but also engineers and scientists. In fact, most employees need to be digitally skilled to some degree. Switzerland is not performing particularly well in this regard. Based on an international survey of executives conducted by IMD, the availability of digitally-skilled workers in Switzerland is only slightly better than the OECD average.

The talent pipeline: a shortage of MINT students

Switzerland performs well in terms of both talent pool as well talent pipeline. The main reason for this is the quality of the Swiss education system. The country ranks second for the quality of its education and training in general science, using an indicator compiled from an annual survey of business leaders conducted by the WEF.

Switzerland performs slightly less well – though still above average – in terms of the quality of its technical universities and departments of computer science. These indicators are compiled from the Times Higher Education World University Ranking tables, and rank countries according to number and status of their universities among the top 100 worldwide.

Abbildung 4. Detailergebnisse Talente



"We are at the beginning of a «War for Talent». Winning nations will be the ones that educate and attract the best and most desirable talents. Switzerland is well positioned, but should consider strengthening expertise in selected key technologies. An example would be to offer a specific programme in the field of blockchain technology."

Nicolas Bürer, Managing Director digitalswitzerland

With its two top-ranking technical universities, ETH and EPFL, Switzerland scores 9 points for the quality and number of its technical universities, outperforming the OECD average of 6 points. The low OECD average can be explained by the high score for the US, which comfortably ranks first because of the large number of its top universities.

A similar picture emerges with regard to the quality of computer science departments. With a score of 13, Switzerland outperforms the OECD average of 9, but the US again leads by a wide margin to top the table with a score of 100.

However, it is not just educational institutions and their quality that determine the success of digital innovation in a country: the number of graduates in MINT subjects is also important. In this respect, Switzerland's performance is only average compared with the rest of the OECD, with a score of 41. Graduates in MINT subjects make up just nine per cent of all graduates. This rather poor performance in relation to other countries such as Germany and the United Kingdom – where MINT graduates make up 15 per cent and 17 per cent respectively of all graduates – is also reflected in the comparative shortage of skilled workers in MINT areas.

Talent appeal: world leader for attractiveness

Switzerland's attractiveness to foreign workers is another important aspect of its digital innovation capacity. Switzerland's demand for skills cannot be met solely by the domestic talent pool; it also relies on being an attractive workplace for foreign talent. In Silicon Valley, for example, two-thirds of all employees in computing and maths are non-nationals.[12]

In terms of attractiveness, Switzerland is among the top performers for all indicators. With a score of 100, based on an annual survey of business leaders conducted by the WEF, it tops the table for its ability to attract and retain talent.

Switzerland scores highest on quality of life, as measured by the OECD's Better Life Index and reflected in factors such as work-life balance, the environment and security. Switzerland also compares well on a qualitative measure of its reputation abroad: the Anholt-GfK Nation Brand Index, based on an international survey, ranks Switzerland eighth.

3.3 Start-ups

A second pillar of the Digital Innovation Capacity Index is a country's entrepreneurial activity and the attractiveness of entrepreneurship, which can be measured by enthusiasm for entrepreneurship, financing, costs, regulation, market and infrastructure. It focuses particularly on start-ups, which make a key contribution to a country's digital innovation capacity. Although established companies also drive digital innovation, start-ups are more likely to take the lead in developing disruptive innovations, which they find easier than established businesses. Start-ups are more focused on innovation and are more agile, and they do not carry the cost of previous investments in older technologies. However, many of the indicators that are important for start-ups are also relevant to established businesses, so a country or region that offers favourable conditions for start-ups is likely to encourage innovation among companies of all kinds.

The start-up rankings in the Index are headed by three countries: the US, Canada and New Zealand. The average for all countries is 43 (almost the same as for talent) and with a score of 43, Switzerland's performance is exactly the same as the average (see Chart 5). It performs badly in terms of venture capital, although this must be seen not in absolute terms but in relation to the top country performers, particularly Israel. However, Switzerland compares well for regulation, market and infrastructure, making for a mixed picture.

Entrepreneurship: right mindset is absent, with high opportunity costs

With regard to entrepreneurship, and especially support for entrepreneurship – as measure by the international Global Entrepreneurship Monitor survey – Switzerland ranks below average. Swiss nationals do not consider start-ups as an attractive career option, their confidence in their own entrepreneurial skills is below average, and they do not consider successful entrepreneurs to be high status individuals. The survey also rates as just average the opportunities for starting businesses in Switzerland. The only factor that can be ruled out as a reason for not starting a business, in fact, is fear of failure: in this area, the Swiss are much bolder than in other countries.

The reason for this mediocre performance may be something that is actually an asset for Switzerland – its efficient labour market. The country offers attractive alternatives to self-employment, with high salaries, low unemployment and much lower youth unemployment than in many other countries. Particularly in their early stages, start-ups rarely make much money, something that many Swiss are reluctant to accept when they have the alternative prospect of a well-paid job in an established company.[13] Even so, both a functioning labour market and Switzerland's social security system – which offers considerably greater security than in many other OECD countries – limit the impact of failure by start-ups.

More surprising is the below-average confidence that the Swiss have in their own skills. The country's education and training system excels in many areas, so good education and training ought in theory to be giving students the skills needed to set up a business.

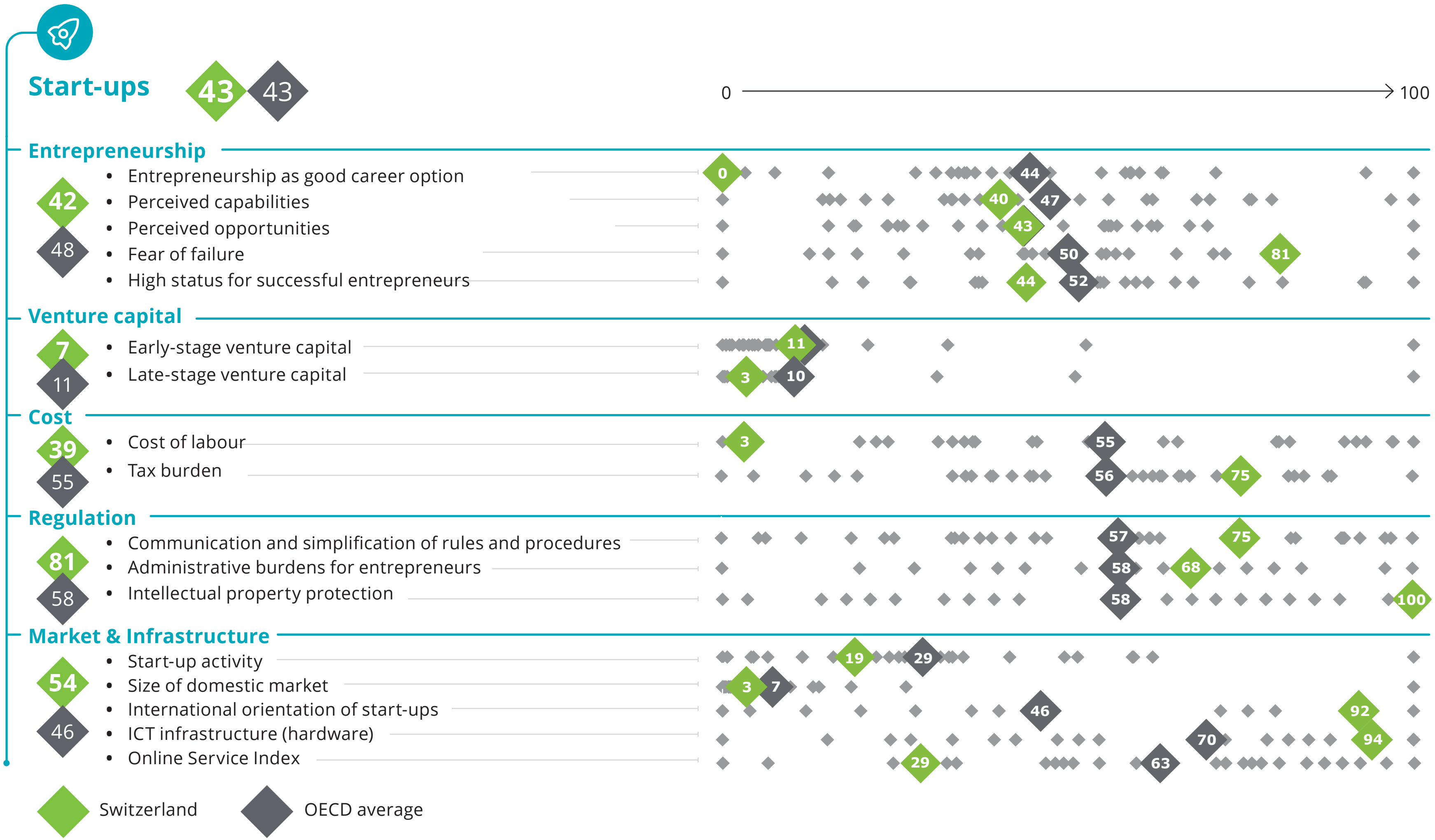
Financing: a mismatch between early and late stages

Early-stage financing for start-ups in Switzerland ranks only slightly below the OECD average, but venture capital financing is a problem area compared with other countries. The reason is the significant gap between the top performers and the average, which makes Switzerland's position look worse than it actually is. Nevertheless, an average ranking in terms of early-stage financing is unsatisfactory, and Switzerland ranks even lower in terms of financing for established start-ups. Investments in venture capital are a high-risk investment, and this limits the number of potential investors, not least because investors also need to ensure that they diversify their investment portfolios. Follow-up financing for established start-ups is generally higher than early-stage financing; these companies have a greater need for finance than new start-ups. This reduces the number of potential foreign investors: Swiss start-ups are competing with significantly larger domestic markets, such as the US market, or with countries better known for their start-up culture, such as Israel.

„By definition, venture capital is risk capital, so in many cases, only a small proportion of available capital is invested. This limits the number of potential investors, in particular where large amounts of capital are involved, as is typically the case with follow-up financing."

Daniel Schoch, Head of Start-up Finance Zürcher Kantonalbank

Chart 5. Detailed results for start-ups



High wage costs in Switzerland

Costs are also an area of weakness for Switzerland, in particular wage costs and overheads. High wage costs mean high opportunity costs for start-ups (see above), are creating obstacles to recruitment and are making it difficult for them to expand. Switzerland performs better on taxation: While capital and asset taxes undermine the substance of start-ups in general, the Swiss federal tax system is flexible enough to allow start-up-friendly tax provisions. Switzerland is an attractive location within the OECD for doing business, in terms of general taxation rates and expenses, for both start-ups and established companies.

Regulation: starting a business is tough

The regulatory framework puts more obstacles in the way of starting a business in Switzerland than in the top-performing OECD countries. The process is considerably more straightforward in New Zealand and Canada, for example. Administrative burdens do not necessarily impede starting a business, but they can act as a disincentive, for example for international entrepreneurs seeking a business location. International comparisons of regulatory burdens rely on several assumptions that might not be equally relevant for all countries. However the OECD indicators for product market regulations that are used for this Index (communication and simplification of rules and procedures, administrative burdens for corporations, administrative burdens for sole proprietor firms),[14] are validated by several other sources.[15 16] Switzerland performs much better on protection of intellectual property, where there can be a conflict of interest between users and producers of innovation and other non-material items. On the one hand, positive external effects are created by facilitating wider use, but on the other hand, producers are protected and there are incentives for high production. The Swiss approach is comparatively pragmatic, without reducing perceived protection.

A small market but good infrastructure

With regard to market and infrastructure, Switzerland performs below average for three indicators but above average for two others. Below-average performance includes start-up activity: this may be due to relatively high opportunity costs and a low perceived attractiveness of entrepreneurship, and also fact that, with favourable alternatives available, Swiss people see less need to start their own business and so do not see start-ups as attractive.

Another indicator for which Switzerland's performance is below average is the size of its domestic market. To some extent, this disadvantage is offset by the country's links with the European single market. Nevertheless, it is easier for companies in larger domestic markets to scale up without the need for separate market launches, and adapted marketing and sales strategies. Indeed, the smaller size of the domestic market may be a reason why Swiss start-ups (along with those from Singapore) are more internationally oriented.*

E-government solutions are less advanced than in other countries. Switzerland is ranked among the highest developed e-government countries in the UN Online Service Index[17] and showing an improvement on earlier years, but compared to other OECD countries there is much scope for improvement. The UK and Australia are ranked best. The mediocre Swiss ranking is confirmed by the EU E-Government Benchmark.[18]

Switzerland's performance is above average for the quality of its digital infrastructure (mobile phone networks, internet connections, secure services, and the availability of electricity).

> "Mentoring programmes are valuable to start-ups, especially in the initiation-phase. Founders not only get in contact with market participants, but can also gather valuable feedback and inputs for putting their ideas into practice."
>
> **Philip Schoch, Co-Founder Apiax**

* This is measured by the proportion of young companies with more than 25 per cent of their customers based outside Switzerland, according to a survey by the Global Entrepreneurship Monitor.

3.4 Investments and patents

A third main pillar of digital innovation capacity is investment in innovation, in the form of both capital investment and investment in digital knowledge capital, as measured by the number of patents.

Digitalisation would be impossible without investment in digital goods and services, while innovation would grind to a halt without investment in digital knowledge capital. Investment therefore plays a key role, with an impact across the economy that extends far beyond the ICT sector itself.

Swiss companies spend a relatively high proportion of their capital on digital goods and services, but the country plays only a minor role in producing them (see Chart 6). In terms of the number of digital patents per head of the population, Switzerland makes it into the top ten countries, but the broad impact of digital technologies is much below average and their use in other areas of technology (level of penetration) is substantially lower than among the top performers. Switzerland's score for this pillar (42) is lower than for the other two pillars, but it still outperforms the OECD average. Most countries score average or below for this measure. The table divides into two, with a few countries – such as Iceland and Estonia – performing well by global comparison, although in some cases, their economies are highly specialised and not active in all areas of technology. Other countries, meanwhile, come towards the bottom of the table.

Investments: high R&D expenditure but little value creation

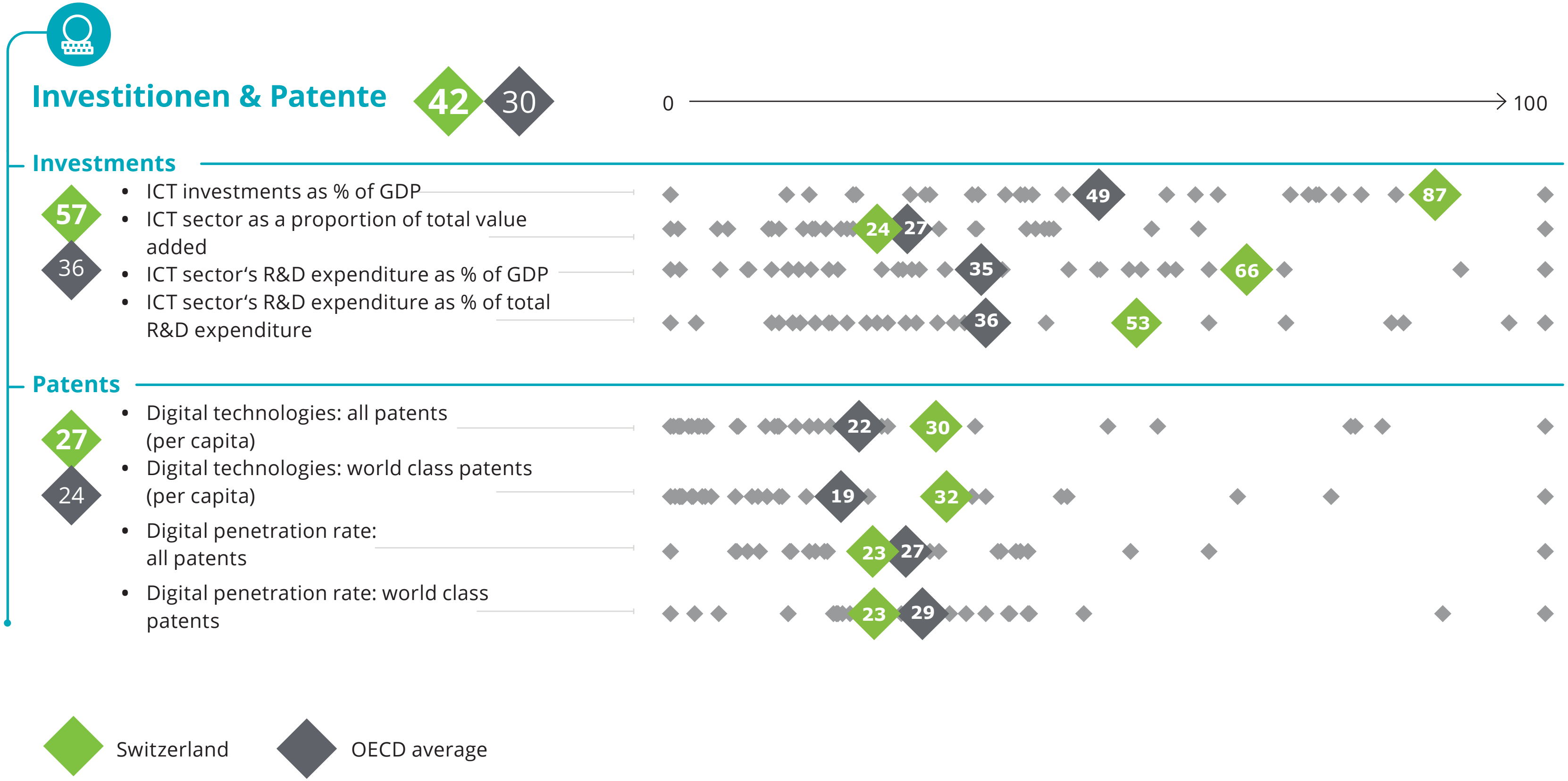
In Switzerland, the proportion of GDP accounted for by investment in ICT is the second highest among OECD countries, although the differences between some countries are very small. Compared with other OECD countries, Switzerland invests a disproportionately high amount in digitalisation, with marked growth in such investments over recent years. Digitalisation has become a buzzword, and is a hot topic in sectors such as financial services.

However, Switzerland lags behind other countries with regard to production of digital goods and services, and performs slightly below average in terms of the percentage of value creation accounted for by its ICT sector. Other business sectors are strong in Switzerland, such as pharmaceuticals, financial services and mechanical engineering; but Other countries such as South Korea have a specialised economy and large companies in these sectors, enabling them to perform better in this area. A diversified economy is not the only explanation for Switzerland's sub-average performance in the production of digital goods and services: the US economy is similarly diversified, yet the US ranks much higher than Switzerland.

Switzerland performs better when it comes to expenditure on the ICT sector, both as a proportion of GDP and as a proportion of total research expenditure. As well as having excellent technical universities, Switzerland is a hub for the research institutes of major digital companies.

However, the number of Swiss companies carrying out research activities is dwindling.[19] These companies devote a substantial amount of time and resources to investment and research, but there are fewer and fewer of them, making Switzerland increasingly dependent on the success of a small number of companies. There is also a risk that businesses investing little or nothing in innovation will become less competitive in the long term. This again emphasises the importance of innovative start-ups, as explained previously.

Chart 6. Detailed findings for investments and patents



Patents: high in quantity but a low level of penetration

Innovation is usually the product, not of new technologies themselves, but by intelligent linking with existing technologies. Digitalisation has an important role in driving networking and change in other technologies, and in improving both processes and products in business sectors outside ICT.

A basic requirement for networking is the availability of digital skills. In basic digital technologies – defined here broadly as patents in the areas of computer hardware and software – Switzerland performs well in comparison with other OECD countries, as Chart 6 shows. It ranks substantially above the OECD average for all patents (per capita) and also performs well in terms of major world-class patents. (For a definition of world-class patents, see Box 1) This gives Switzerland an excellent foundation for making use of digital technologies.

To improve comparability, the findings were standardised and calculated on a per capita basis to compensate for differing population sizes. The resulting digital penetration ratings are shown in Chart/Figure 6 for both patents in total and also for world-class patents separately. These ratings show not only which countries are actively involved in driving digitalisation, but also how good they are at it.

With regard to the penetration level of digital technologies , however, the picture is rather different. Penetration is a measure of the extent to which digitalisation is incorporated with other technologies. For the purpose of building the Index. patents around the world were allocated to one of 33 technology areas and an assessment was made of patents that could be counted both as digital technology and as traditional technology. In such cases, digital elements are assumed to have fed into the patent in question.

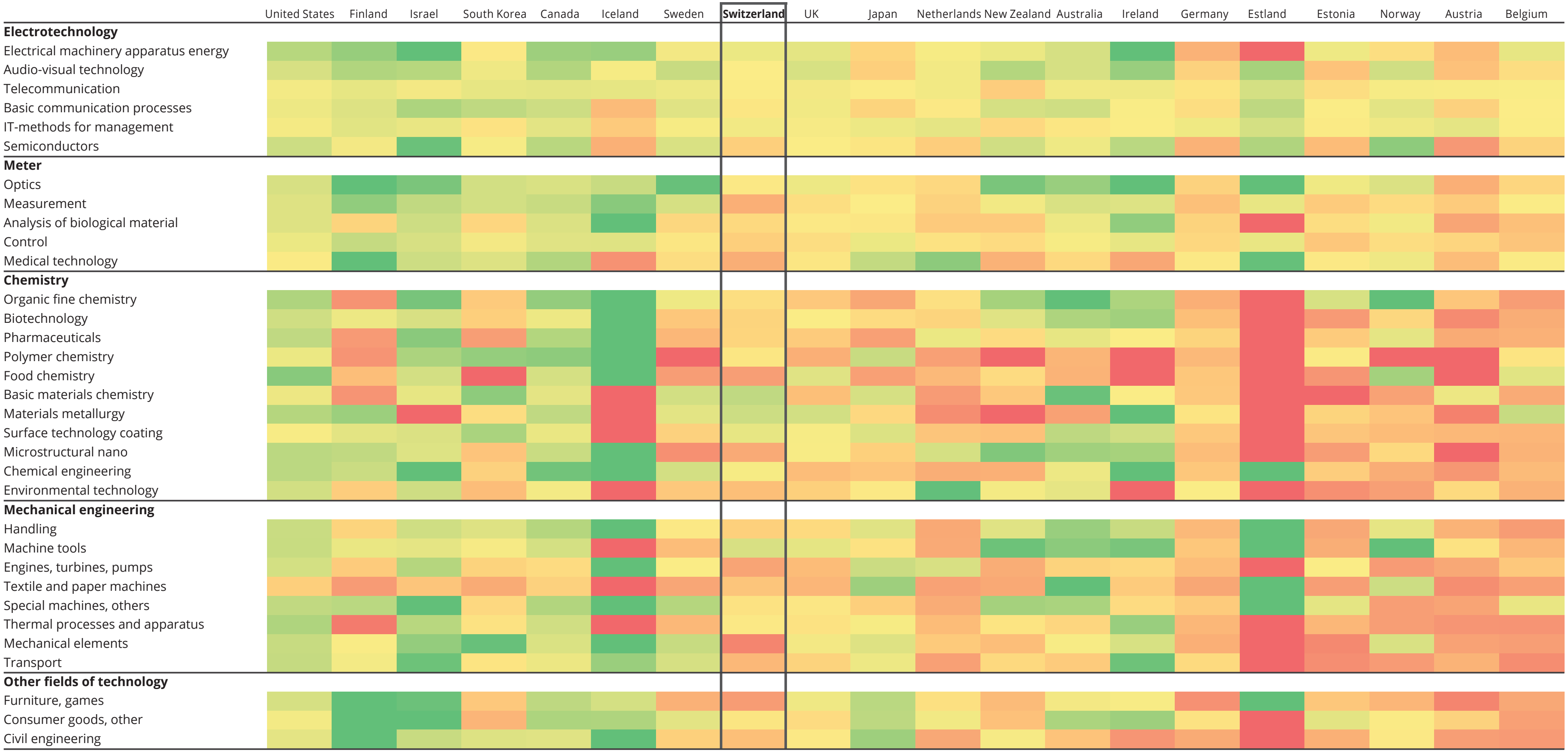
As Chart 6 shows, Switzerland performs below the OECD average on penetration, in relation both to all patents and also to world-class patents.

Chart 7 shows a more detailed representation of the extent to which digitalisation has penetrated world-class patents. This 'heat map' portrays the level of digitalisation of world-class patents, broken down by country and by area of technology. Across all technologies – with the exception of some individual chemical technologies – Switzerland underperforms the OECD average. The penetration of other technologies by digitalisation is therefore much less extensive than in many other OECD countries. Its position in the table applies both to the traditional assessment of all patents and to the particular assessment of world-class patents.

Iceland, Israel and Estonia lead the way in digitalisation, ahead of Canada and the US. This demonstrates that there are other ways than sheer size of achieving a good strategic ranking, as is the case with the US. It is also striking that major European industrialised economies, such as Germany and France, lag behind Switzerland.

The key finding in relation to Switzerland is that it is holding its own internationally in individual technology areas, but that it performs less well when all technologies are aggregated. Unlike the majority of its competitors, it is not making adequate use of its existing digital skills to develop new technologies. This should give businesses food for thought, particularly against the backdrop of increasing interlinking of technologies. The challenge for Switzerland will therefore be to drive forward the networking and interlinking of its technological capabilities.

Chart 7. Heat map of digital penetration of other technologies



The heat map is designed to be read horizontally and illustrates the digital penetration of a particular technology across countries by comparison with the OECD average. A dark green entry means that technology in the country in question is penetrated to a significantly above-average level. Dark red means that the level of digital penetration is significantly below average. Some technologies are, by definition, penetrated to a higher degree than others, so simply reading vertically to compare countries does not give an accurate picture.

Source: BAK Economics

3.5 Focus on selected technologies

The Digital Innovation Capacity Index demonstrates how well Switzerland performs in the development, use and commercialisation of digital technologies. To illustrate the differences between individual technologies, this section will consider three major future-oriented technologies more closely: process automation, artificial intelligence and batteries. Patent data form the basis for this analysis.

Process automation is a key component of industry 4.0 and comprises control and regulation processes for machinery. Artificial intelligence, which also includes machine learning and neural networks, is a core element in the expected advance of digitalisation. Battery technology includes basic energy storage systems and traditional applications for electromobility – a highly topical issue. This analysis considers world-class patents per million inhabitants for each of the three technologies, a method that allows for the different country population sizes.

World-class research in Switzerland

As Chart 8 shows that on a population-weighted basis, Switzerland is one of the most active developers in the field of process automation. Other countries with a strong industrial base also perform well in this area.

Artificial intelligence (AI) is one of the key technologies that will be driving the next major advances in digitalisation. AI and machine learning are vital for realising the advantages that analysis of big data can bring. Many countries are therefore focusing intensively on this area. In terms of its per capita figure for world-class patents in AI, Switzerland ranks seventh and substantially outperforms the OECD average.

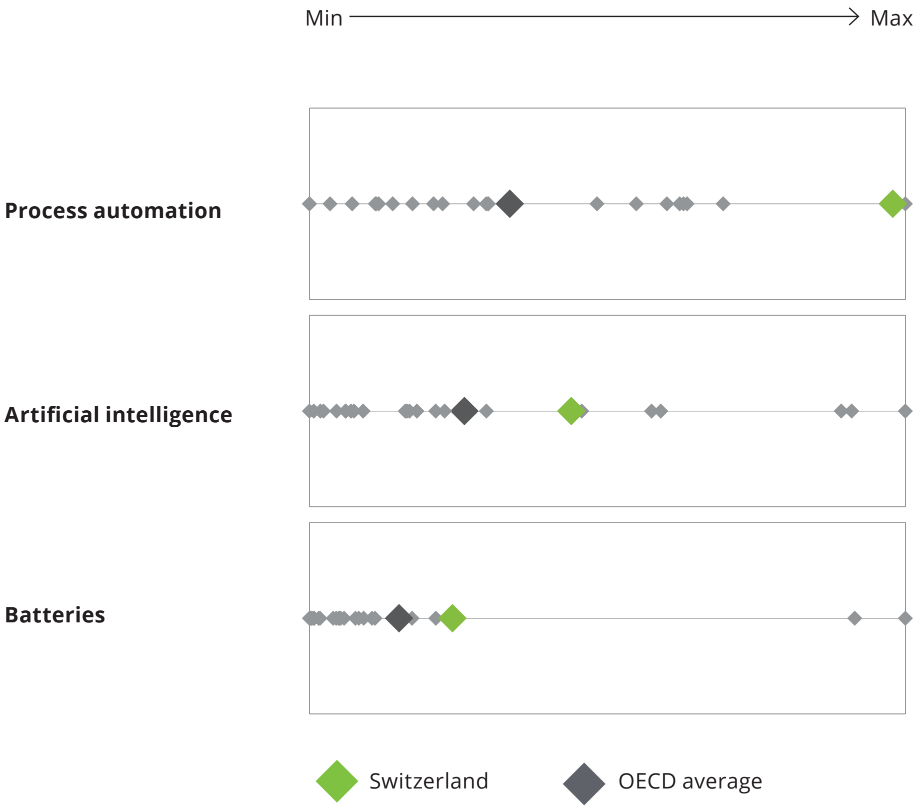
Battery research underpins the design of all future forms of mobility, and Switzerland ranks third in this area, behind Japan and South Korea. It also outperforms the OECD average.

Overall, the focus on future-oriented technologies demonstrates that Switzerland is carrying out world-class research into individual technologies. Nevertheless, in absolute terms, large countries still have more world-class patents: the US and Japan have the highest number of world-class patents, winning out both in terms of quality and critical mass.

North American dominance

A regional focus on individual technologies for OECD countries reveals marked trends toward specialisation (see Chart 9). Research in the area of artificial intelligence is heavily focused on North America (which accounts for 77 per cent of all AI patents), and Asia (South Korea and Japan) has 64 per cent of all world-class battery patents, giving it a clear advantage in this area. Process automation, however, is well established across all three main continents, indicating that a country's manufacturing base can drive its research activities.

Chart 8. World-class patents per head of population in three selected future-oriented technologies in Switzerland compared with the OECD



Note: the chart shows the standardised distribution of all OECD countries, with the poorest performers on the left and the best performers on the right. Source: BAK Economics

Box 1: Measuring patents – quality, not quantity

Technological progress is decentralised and is achieved at company level, and is the result of strategic corporate decisions about how factors of production are used. One of the few methods available for measuring such activities is through the international patent system.

Measuring research and innovation capacity by means of patents has traditionally produced unsatisfactory results: country-specific differences in registering patents tend to distort comparisons. For example, researchers in China are encouraged to register as many patents as possible to boost China's importance as a research hub.

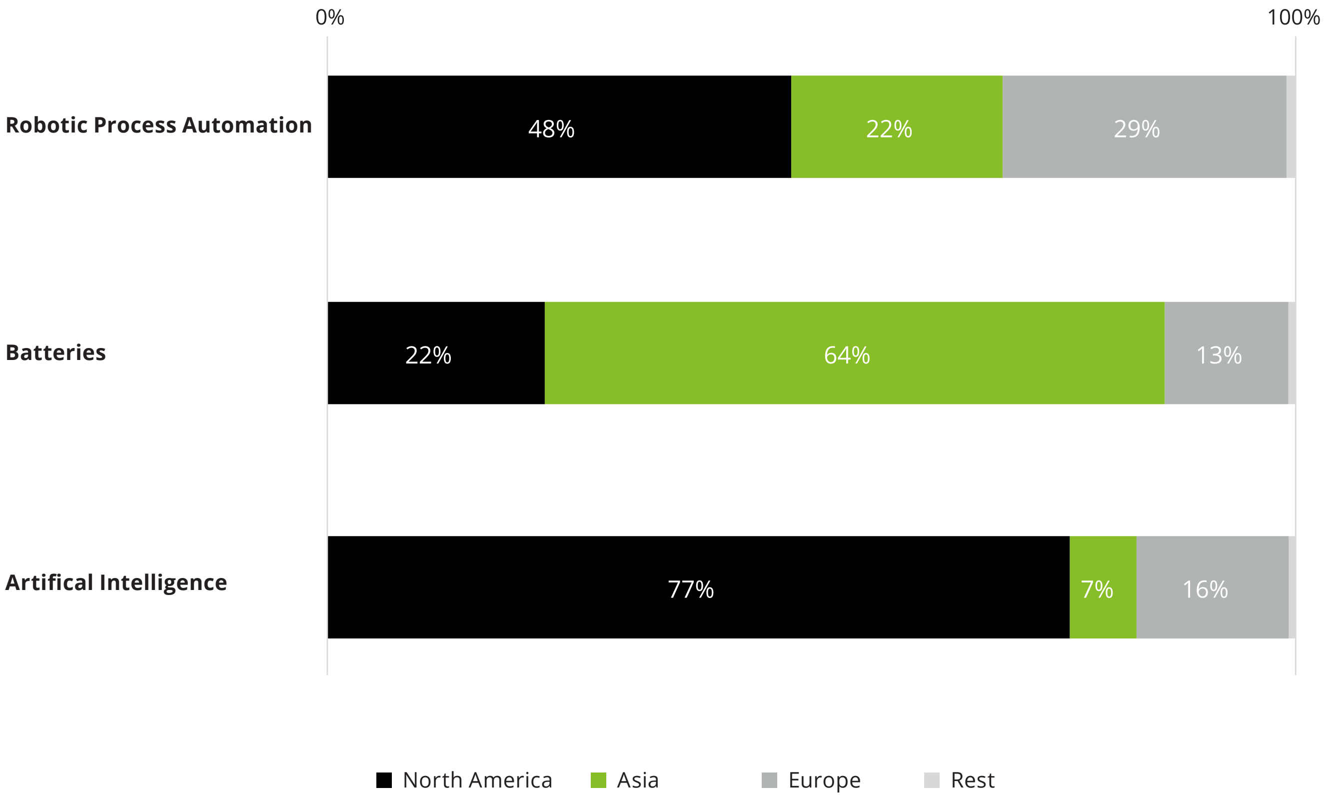
Simply measuring patent activity in terms of applications therefore gives a false impression of the significance of countries and distorts the overall picture. Moreover, it simply counts patents and does not rank the relevance of the discoveries to which they relate. In other words, traditional approaches measure quantity rather than quality.

The new BAK Economics technology approach, developed jointly with the Swiss Federal Institute of Intellectual Property and PatentSight, breaks new ground by basing measurement on patent quality. For each technology, the most important patents around the world are identified and attributed to countries, regions and companies. This excludes all non-significant and unknown patents, producing a basis for classifying a patent as 'world-class'. Quality assessment is carried out globally for each patent, making this a pioneering methodology for portraying world-class patents in future-oriented technologies, by measuring quality rather than quantity.

The Digital Innovation Capacity Index allocates each patent around the world to one of 33 areas of technology to assess the extent to which it is penetrated by digitalisation technologies.

Source: BAK Economics

Chart 9. Proportion of world-class patents by continent

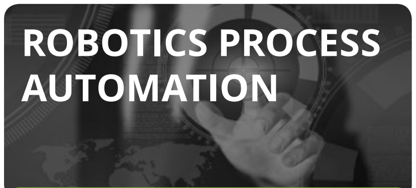


Source: BAK Economics

Box 2: Application of RPA and cognitive technologies

Process automation (mostly robotics process automation, or RPA) and artificial intelligence (mostly cognitive technologies) are already being used in a wide range of business areas and functions.

- **RPA** is used for rule-based structured tasks with a high processing volume that have traditionally been carried out by employees using computers. These tasks include, for example, compiling various types of report or copying across information from one program to another. Robotic software can work with a range of applications, such as opening and processing emails and email attachments and copying the data across to other programs. RPA therefore has the ability to imitate structured human working processes but at a markedly higher speed and with significantly fewer errors.
- **Cognitive technologies** involve the use of artificial intelligence in a range of different areas, normally replicating or supplementing human intelligence. The use of cognitive technologies enables human employees to configure computer software to acquire and extract knowledge, recognise patterns, and learn and adapt to new situations and environments. Broadly speaking, cognitive technologies cover three areas. The first is 'cognitive automation', in which speech recognition and language processing are central. The second is 'cognitive insights' – the processing of a wide range of structured and unstructured data for the purposes of data processing and retrieval. The third is 'cognitive engagement', which combines speech recognition, advanced online user interfaces and machine learning to improve interaction with customers or employees.



Automating manual processes based on structured data, such as form completion, data entry and document classification, and automatically generating reports from data

Copying the information from the form to the system, finance reporting, processing of patient reimbursement requests

Leverage natural language processing (NLP) and natural language generation (NLG) to process text documents automatically, quickly, and without errors. Enhance data preparation quality based on supervised machine learning to increase business rules to address exceptions / error handling

Market access contract review, invoice checking, global master data updates with high number of local exceptions

Process high volume of data in structured and unstructured format, extract the information and drive insights, Self-learn from multi-structured historical data to process or advise on decisions for complex activities

Brand feedback and complaints analysis using natural language processing, insurance risk analysis

The fusion of voice recognition and advanced online interfaces with machine learning to interact with customers, medical patients, suppliers and colleagues on narrow specific topics

Natural Language Processing (NLP) bots are being used to interpret customer or employee questions and automatically fetch robust responses

4. Conclusions and recommendations

"Successful regions make Switzerland a highly coherent country. It is also in the happy position of having several major innovation hubs, including the area around Lake Geneva, the Greater Zurich Area as well as others. The challenge will be not only to strengthen Switzerland's global competitiveness but also to maintain domestic regional coherence."

Eric Jakob, Ambassador and head of SECO's Promotion Activities Directorate

4.1 Key findings

In comparison with other industrialised economies, Switzerland's performance on many economic indicators is above average. The country enjoys excellent competitiveness, low unemployment and low government borrowing. The exception is its performance on productivity: productivity growth has not only declined over recent years but has actually fallen below the level achieved by other industrialised economies.

This trend is a cause for concern because, over the long term, productivity growth is a decisive driver of per capita GDP – the measure of a country's prosperity.

The central role of digital technologies

The impact of digitalisation has yet to make itself felt in productivity statistics, but there can be no doubt that digital technologies represent the greatest potential for higher productivity. This means that not only businesses but also the state must exploit the available potential. There is scope here for Switzerland to take action.

Against this background, Deloitte devised the Digital Innovation Capacity Index to measure Switzerland's performance against other OECD countries in developing, using and commercialising digital technologies.

Switzerland: good, but not good enough

Overall, Switzerland performs relatively well with a score of 51 and ranks eighth out of 35 OECD countries. However, this is16 points below the US, the top performing country, and although it outperforms the OECD average, there is still substantial ground to make up on the top performers. The findings therefore show a rather different picture from the familiar and widely-cited innovation and competitiveness rankings that Switzerland has topped for many years.

This suggests that Switzerland's current innovative strength can be attributed largely to traditionally strong sectors, such as pharmaceuticals, chemicals and mechanical engineering. In terms of its digital innovation, however, Switzerland lags somewhat. The most recent list of the world's most innovative companies, based on a survey of company managers, confirms this: there is not a single Swiss company in the top 50.[20] Digital players including Apple, Google, Airbnb, Netflix and Uber top the rankings, demonstrating that the most highly regarded innovations are in the digital sector, particularly in the business-to-consumer sector.

4.2 What should Switzerland be doing?

The Digital Innovation Capacity Index shows the areas in which Switzerland has the greatest potential for improvement.

Talent: strict third country quotas and a shortage of graduates in MINT subjects

Switzerland's very good performance on the first pillar – talent – indicates that there is limited scope for improvement in this area. The country has a highly skilled workforce and an excellent education and training system. It is also very attractive to talent from abroad. However, while the country performs well or very well on most talent indicators, there are three weak spots.

First, its performance in terms of the number of graduates in MINT subjects is only middling compared with the rest of the OECD. The comparative shortage of skilled workers in technical areas shows that Switzerland urgently needs to make improvements here. It is important to generate greater enthusiasm among young people for technical occupations and to strengthen cooperation between schools and companies. Initial steps have been taken to boost such cooperation.[21]

Second, there is room for improvement when it comes to the level of digital skills among Swiss employees. Schools should focus more on ICT skills in basic education. In particular, efforts should concentrate on an understanding of digital technologies, such as how algorithms work or the basics of programming. Digital skills are becoming a core requirement across all sectors and occupations. As a recent Deloitte study shows, it is also important to combine technological skills with social skills.[22]

The third weak spot is the recruitment of labour from non-EU countries, which is subject to strict quotas and often cumbersome administrative procedures. These obstacles are sometimes enough to deter businesses – and small start-ups in particular – from recruiting from outside the EU, cutting them off from a major source of top global talent. Relaxation of these rigid regulations would make it easier for many high-tech companies to recruit the digital specialists they need to compensate for shortages in the Swiss labour force.

Start-ups: boosting entrepreneurship and dismantling obstacles

Switzerland has much more ground to make up on start-ups. A core weakness is the lack of enthusiasm for entrepreneurship. There is little scope for improvement in this areas, given the comparatively high opportunity cost of setting up a business – Switzerland offers high salaries and an attractive labour market, and while these factors are a real strength of the Swiss economy, they also reinforce low levels of enthusiasm for entrepreneurship. However there is scope for tackling this issue in terms of the social perceptions and the status of entrepreneurship. The education system could do more to raise awareness of entrepreneurship, but this needs to be done at primary and secondary level and not left until students are at university. More specifically, entrepreneurship and start-ups need to be presented to students and apprentices as valid career choices. The way these ideas are presented must be practical and realistic, which requires teaching staff to be trained both through in-service training and also greater involvement by external experts. Existing initiatives to take practical business experience into schools and universities are a step in the right direction. Sources of help and support with starting a business are also important, whether through links between business and universities, start-up initiatives within universities, or private sector accelerators. Switzerland has already significantly improved its position in this area, but still lags behind the top performing countries.

"Switzerland is traditionally speaking a highly innovative country. With the appropriate investments, this attribute can be preserved. It is crucial that first, digital skills are taught to the coming generations, second, the active working force needs to be encouraged for lifelong-learning, and third the most gifted talents must continuously be attracted to the Swiss labour market. Those three factors guarantee the future conservation of competitiveness in the fields of research and economy."

Patrick Warnking, Country Manager Google Switzerland

"To promote entrepreneurship, a complex eco-system is needed - thus, a supportive culture at the universities. It is necessary to set a course for the founding of new start-ups, to create incentives for action, to show advantages and provide measures of support in the fields of finance, mentoring, and networking."

Prof. Dr. Lothar Thiele, Digital Transformation ETH

Much the same is true of financing. Switzerland performs only slightly below the OECD average on early-stage financing, and this area was not often identified by our expert interviewees as a problem. However, the country lags behind its comparators in terms of late-stage financing. Although capital investment in late-stage financing and digital technologies has increased over recent years, there is still room for improvement. If institutional investors put even a small proportion of their assets into venture capital, this would significantly improve the capital available. A number of initiatives are already in place and are taking the country in the right direction: these include the Swiss Future Fund (an initiative created with impetus from a range of private individuals, politicians and business people) and the Swiss Entrepreneurs Foundation set up under the patronage of Federal Councillor Johann Schneider-Ammann. Both initiatives were launched very recently.

The processes of setting up a business and declaring insolvency in Switzerland are lengthy and costly in comparison with other countries. In some cases this can be offset by private or public sector support or more advanced e-government solutions. Easier and faster solutions for (future) companies will facilitate faster setting-up of companies. The Federal authorities have recognised the need for reforms, and have built the online platform easy.gov (https://www.easygov.swiss), for example. It is important, however, that cantonal and local authorities should follow suit.

The solution lies not simply in compensating for complex rules but also in simplifying the regulatory framework. For example, the OECD has identified a number of areas of insolvency law that need improvement, including creation of a functioning insolvency law for private individuals, to make it easier for failed start-ups to have a second chance.[23]

Investments and patents: greater networking between education and the private sector

With regard to investments and patents, Switzerland has three areas of weakness to tackle. First, while the country is strong in research, it is less successful at creating value – that is, at producing digital goods and services. Second, research output is confined to an increasingly small number of companies. And third, the penetration of digitalisation into traditional technologies is far below the OECD average. Short of adopting an industrial policy that nobody wants and that will cause long-term damage, there is little the state can do. The main priority is to strengthen Switzerland as a production hub, and the most important way of achieving that is to improve conditions in both the digital and the non-digital sectors. There is also room for targeted action to promote research and innovation, particularly through taxation.

As a study by the Centre for European Economic Research (ZEW) shows, fiscal incentives to innovate can be crucial to government efforts to promote innovation.[24] Incentives are easier to introduce and manage than direct payments. ZEW notes that input-oriented incentives such as tax relief on R&D expenditure have a particularly positive impact on a country's innovation activities.

Following defeat of the Federal Council's Swiss Corporate Tax Reform III (USTR III), the newly launched 'Tax Reform Proposal 17' (as at January 2018) offers key elements of fiscal support for private sector innovation – a 'patent box' and tax 'super-deductions' for research and development – and represents a step in the right direction. However, one possible weakness of the Proposal is that, unlike both USTR III and OECD standards, the patent boxes exclude patented software, which is of particular relevance to ICT.

One further indirect impact on the promotion of research and innovation is government demand for goods and services. The greater the trend towards e-government, the greater will be the state's demand for digital goods and services from private sector providers. Putting e-government in place has a number of effects. It can reduce administrative costs and make public bodies more efficient. It is also a signal to private sector digital providers that the state is a major client for digital products. However, it is self-evident that e-government needs to be driven pragmatically and to the highest security standards. The mass blocking of electronic identity cards in Estonia in November 2017 is a negative example and a warning. Estonia is considered a pioneer of e-government, but this incident damaged its credibility.

A wider roll-out of e-government to rigorous security standards would support Switzerland's global reputation as a secure location for e-business and encourage digital products and services in this area, such as high-level data protection for servers and emails.

Improving Switzerland's performance with regard to patents will require more networking between the education and private sectors, including training centres, companies, business associations and government agencies. Knowledge transfer should be strengthened, and patents exploited and commercialised. The same is true of interdisciplinary links within institutions and companies. As indicated by Switzerland's below-average digital penetration performance within the OECD, there is a need for improvement. Better networking, both between companies and between institutions, should not be used to hamper competition between companies (for example, in the area of taxation), cantons or education institutions. Rather, the aim must be for all market players to be able to compete meaningfully, by focusing on core areas and core skills. This focus should be not just on regional competition, but also on global competition, something that tertiary education providers are well placed to enhance. These institutions will, however, have to concentrate more on their core areas – basic research in the case of universities and applied research in the case of universities of applied science. Companies could also collaborate in a targeted way on specific large-scale and costly projects by means of joint ventures. One example is Switzerland's electronic ID scheme. Nine major Swiss companies are involved: Credit Suisse, UBS, Mobiliar, Six, Raiffeisen and Zurich Cantonal Bank as state-affiliated companies and the state enterprises Swiss Post, Swisscom and Swiss Federal Railways (SBB).

"Even the best innovation is worthless if it is not sold. However, sales activities often are considered as a negligible factor on the path towards success. This attitude backfires when competitors with similar or even inferior ideas, but better sales personnel have more success on the market."

Angelo Buscemi, Country Manager Adobe Switzerland

"There are three phases of digitalisation. The first, digitizing information, which is still on-going, with different maturities across countries, industries and enterprises. The second phase is making sense of the massive amount of data collected from the previous phase using AI. And the third phase is Industry 4.0 and the ability act on the insight obtained from the data, such as predictive maintenance. Even if it is not yet fully applied by everyone, the technology for the first phase has largely been created, therefore IBM is concentrating on the development of technologies for the second and third phases."

Dr. Alessandro Curioni, IBM Fellow, VP Europe and Director, IBM Research - Zurich

4.3 What should companies be doing?

The recommendations set out below include that the government could be taking to improve Switzerland's digital innovation capacity and increase productivity. Nonetheless, the government would be well advised to avoid adopting a targeted industrial policy, and to restrict its interventions to putting a favourable framework in place.

Ultimately, what will decide success in this area is the extent to which companies invest in developing and using digital solutions and optimising their processes. With the right incentives and framework, government can make a significant contribution here, but ultimately its influence is only indirect. Company initiatives are therefore crucial to improving Switzerland's position in the digital innovation capacity rankings.

Untapped potential

Swiss businesses have long recognised the importance of digitalisation. It has become a 'hot topic' and is now a theme included the annual reports of many companies. Yet the potential for digitalisation remains largely untapped in most companies. In many cases, remedial action is needed at the very initial stage – digitalisation of information, where there is fundamental scope for improvement, even where -more advanced aspects of digitalisation may not be possible. It makes no sense, for example, to use big data or apply artificial intelligence solutions if the underlying data are still partly or wholly non-digital.

Untapped potential for digitalisation is a key contributor to disappointing productivity growth, as demonstrated in section 2 of this report. Without further-reaching corporate and customer-oriented digital solutions, innovations will not achieve their full impact.

Success factors in the digital transformation process

This raises the issue of exactly how Swiss businesses can make better use of their potential for digitalisation and which factors will be crucial to the digital success of individual companies. To supply some answers, Deloitte collaborated with MIT Sloan Management Review to identify the differences between digitally advanced and digitally underdeveloped companies.[25 26] The critical success factors in digital transformation within a company are strategy, talent management, corporate culture and leadership.

1. **Strategy:** Ucompanies with a low level of digitalisation often lack a clear and coherent strategy in this area, focusing instead on individual and discrete technologies. However digitalisation should not be an end in itself, but rather the means to achieving strategic corporate goals.[27] The crucial requirement is therefore to focus on strategy rather than on the individual technology. Digitally mature companies are much more likely to have a clear and coherent digital strategy in place and to communicate this strategy effectively across the company than companies that have made less progress towards digitalisation. This strategy is also more likely to focus beyond technical solutions, and on strategic goals such as improved decision-making, innovation or business transformation, as Chart 10 shows.

   Companies not directly involved in developing digital technologies may find it difficult to gain a technological edge over their competitors. Most digital technologies are available to all companies in all business sectors, and the improvements they bring are not inherent in the technologies themselves, but derive from the ways in which they are used. Technologies need not always be cutting edge, nor do companies necessarily need to implement them across their entire operations. For example, instead of replacing the entire IT legacy infrastructure in one fell swoop, there are more pragmatic individual measures that businesses can take, such as developing an advanced user interface that can be superimposed on existing systems to enable efficiency gains through simplified operation.

Small steps towards innovation and a wide-reaching strategic vision are not mutually exclusive options. Indeed, digitally mature companies are twice as likely as less digitalised companies to be taking small innovative steps as well as company-wide initiatives. One of the major obstacles to innovation is having too many conflicting strategic priorities. Driving digitalisation forward should be a core component of a company's business model. Companies need to make decisions as to which individual aspects of corporate culture – such as customer interface or customer experience, organisation, leadership or processes – should be adopted.

2. **Talent-Management:** alongside strategy, the development of employees is also crucial. Companies need to find and recruit the best employees with future-oriented skills. They also need to invest in their existing workforce and to ensure that its skills and aptitudes are adapted and expanded. As Chart 10 shows, there is a major difference between 'early' (or 'developing') and 'maturing' companies in this respect.

   Most companies employ staff with a particular interest in digital transformation and should identify and deploy these individuals to drive the change process. Staff with an interest in digitalisation will be keen to achieve change, something that represents a decisive advantage in a rapidly evolving environment. As the Deloitte and MIT Sloan Management Review survey shows, most employees want to work in companies that make use of digital technologies or even lead the field. The differences between age groups is less than is frequently assumed. In the US, for example, the 60-plus age group is the least likely to attach importance to working in a company that leads the way in using digital technologies, although 72 per cent of them hold this view. Among the 22 to 27-year age group, the most likely to attach importance to working for a company that leads the way in using digital technologies, the proportion is 85 per cent.

   Digitalisation enables companies to improve their employee recruitment, motivation and development. Targeted continuing training geared to the company's needs means not only that employees' skills can be adapted to new circumstances but also that employee motivation can be increased. New technologies create new opportunities for employees to learn from each other and develop their skills, through social learning, for example, or internal forums. Further opportunities can be created by setting up an internal video channel, or by 'gamifying' the learning environment and creating incentives for employees to improve their performance. Depending on an employee's specific job, virtual learning and simulations may also be used: practical situations are often more effective than pure theory. Data analysis can be used to evaluate and improve the effectiveness of different learning methods on an ongoing basis, both at individual and at corporate level[28], and shared priorities and cross-functional incentivisation also boost cooperation.[29]

"It is important to convince employees of the benefits of transformation processes and inspire them. Therefore, storytelling is a crucial element in digital transformation processes."

Egon Steinkasserer, Head of Innovation Swisscom

3. **Corporate culture:** digital change cannot be imposed by senior management. If digitalisation is to be sustainable, corporate cultures must be geared to change. This requires a supporting culture that combines risk appetite, willingness to collaborate and enthusiasm for experimentation. Flexibility, combined with a networked and team-based corporate structure, is particularly valuable in supporting digital transformation. In 'early' digitalisation companies, such a culture is rare, however, as Chart 10 shows.

   Promoting cross-functional collaboration is crucial: the introduction of digital technologies blurs the lines between formerly discrete areas of skills. In other words, innovation requires greater cooperation. An example of this is driverless cars, whose manufacture requires not only traditional mechanical engineering skills but also expertise in artificial intelligence. These two areas must interact seamlessly. Collaboration brings together previously discrete areas of knowledge, but also promotes creativity and creates new perspectives. Technology can play a supporting role here, for example through the use of social networks within the company to bring together employees with similar interests and roles.

4. **Leadership:** digital transformation of a company will not succeed without skilled and trained leaders. As Chart 10 shows, only 15 per cent of those surveyed in 'early' digitalisation companies thought their leaders had adequate digital skills. In 'digitally maturing' companies, by contrast, the figure was 76 per cent. In other words, employees in 'digitally maturing' companies have much more confidence in the digital skills of their leadership team.

   This does not mean that all managers need to be technological specialists. What is more important is a solid fundamental understanding of digitalisation and the impact and opportunities it creates for the company. Recognising strategic implications is particularly important, but managers also need to set a good example and create the environment needed for digital transformation.

Chart 10: Success factors for companies in the digital transformation process

	Digital maturity		
	EARLY	**DEVELOPING**	**MATURING**
Strategy	**Customer end productivity driven** Approximately 80% cite focus on customer experience (CX) and efficiency growth	**Growing vision** CX and efficiency growth; over 70% cite focus on transformation, innovation and decision making	**Transformative vision** Over 87% cite focus on transformation, innovation and decision making
Culture	**Siloed** 34% collaborative; 26% innovative compared to competitors	**Integrating** 57% collaborative; 64% innovative compared to competitors	**Integrated and innovative** 81 % collaborative; 83% innovative compared to competitors
Talent Development	**Tepid interest** 19% say their company provides resources to obtain digital skills	**Investing** 43% say their company provides resources to obtain digital skills	**Committed** 76% say their company provides resources to obtain digital skills
Leadership	**Lacking skills** 15% say leadership has sufficient digital skills	**Learning** 39% say leadership has sufficient digital skills	**Sophisticated** 76% say leadership has sufficient digital skills

Source: Kane et al. (2015)

Appendix

5. Endnotes

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Talente		
Pool		
	Availability of scientists and engineers	WEF (2017), The Global Competitiveness Report 2017-2018
	ICT specialists	OECD (2017), Education at a Glance 2017
	Availability of digitally skilled workers	IMD (2016), IMD World digital competitiveness ranking 2016
Pipeline		
	MINT students (share)	OECD (2017), Education at a Glance 2017
	Quality and number of technical universities	THE (2017), Engineering and Technology Ranking
	Quality and number of IT faculties	THE (2017), Computer Science Ranking
	Quality of maths and science education	WEF (2017), The Global Competitiveness Report 2017-2018
Appeal		
	Capacity to retain talent	WEF (2017), The Global Competitiveness Report 2017-2018
	Quality of life	WEF (2017), The Global Competitiveness Report 2017-2018
	Reputation	GFK (2016), Nation Brand Index
	Capacity to attract talent	WEF (2017), The Global Competitiveness Report 2017-2018

Start-ups		
Entrepreneurship		
	Entrepreneurship as good career option	GEM Consortium (2017), Adult Population Survey 2016
	Perceived capabilities	
	Perceived opportunities	
	Fear of failure	
	High status to successful entrepreneurs	
Venture capital		
	Early-stage venture capital	OECD (2017), Entrepreneurship at a Glance 2017
	Late-stage venture capital	
Cost		
	Cost of labour	IW Köln (2017), Lohnstückkosten im internationalen Vergleich
	Tax burden	World Bank (2017), Doing business 2017
Regulation		
	Communication and simplification of rules and procedures	OECD (2013), Economy wide product market regulation (PMR)
	Administrative burdens for entrepreneurs	
	Intellectual Property Protection	WEF (2017), The Global Competitiveness Report 2017-2018
Market & Infrastructure		
	Start-up activity	GEM Consortium (2017), Adult Population Survey 2016
	Size of domestic market	World Bank (2017), Gross domestic product 2016
	International orientation of start-ups	GEM Consortium (2017), Adult Population Survey 2016
	ICT infrastructure	WEF (2016), Global Information Technology Report 2016
	E-Government Online Service Index	UN (2016), United Nations e-government survey 2016

Investments & patents		
Investments		
	ICT investments as % of GDP	OECD (2017), OECD Digital Economy Outlook 2017
	ICT sector as a proportion of total value added	
	ICT sector's R&D expenditure as % of GDP	
	ICT sector's R&D expenditure as % of total R&D expenditure	
Patents		
	Digital technologies: All patents (per capita)	BAK Economics (2017), IGE, PatentSight
	Digital technologies: world class patents (per capita)	
	Digital penetration rate: all Patents (per capita)	
	Digital penetration rate: world class patents (per capita)	

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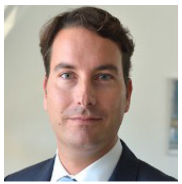

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