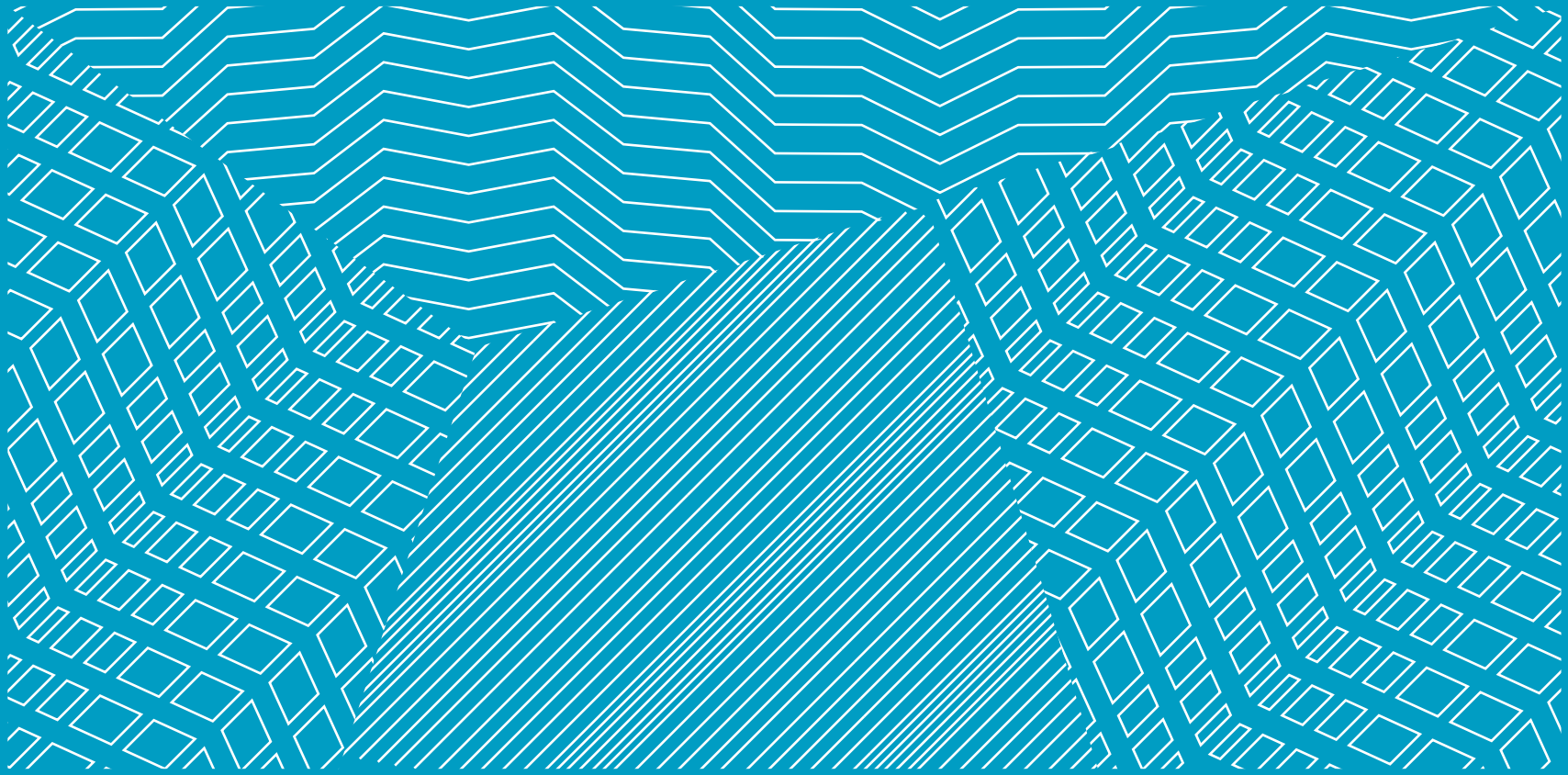
MIKA NAUMANEN
ANNA LEINONEN
OLAVI LEHTORANTA
TORSTI LOIKKANEN
MIKA NIEMINEN
ANTTI PELKONEN
PEKKA PELLINEN
JULIA PARKKO

TEKBARO 2017

TECHNOLOGY BAROMETER ON PUBLIC ATTITUDES AND ORIENTATION TOWARDS A KNOWLEDGE-BASED SOCIETY



TECHNOLOGY BAROMETER 2017

TEKBARO 2017

Publisher	Tekniikan akateemiset TEK
Layout	redandblue
Imposition	Kirsi Pääskyvuori, Painomerkki Oy
Cover picture	redandblue
Imprint	Painotalo Plus Digital Oy, Lahti
ISBN	978-952-7098-11-0

TECHNOLOGY BAROMETER
ON PUBLIC ATTITUDES
AND ORIENTATION
TOWARDS
A KNOWLEDGE-BASED
SOCIETY

TEKBARO 2017

MIKA NAUMANEN
ANNA LEINONEN
OLAVI LEHTORANTA
TORSTI LOIKKANEN
MIKA NIEMINEN
ANTTI PELKONEN
PEKKA PELLINEN
JULIA PARKKO

Contents

To the reader

The Technology Barometer of 2016/2017 is the seventh of its kind, with the first in the series having been published in 2004. Over the years, a great many individual updates and innovations have been made, but the basic structure of the Barometer remains true to the original idea.

The Barometer has drawn extensive interest and opened up new perspectives into the debate on our innovation system. The concept has proved its usefulness, since many of the perspectives raised in previous Barometers have been confirmed concretely through actual developments. The instrument has been capable of predicting many of the momentous changes that have taken place in recent years, before they have become topics of widespread public discussion and debate.

South Korea joined the comparison group of the Barometer's indicator section in 2014. As a result, this time the material on that country is more comprehensive than before. The Science and Technology Policy Institute STEPI in Seoul has had the main responsibility for collecting the material on South Korea. Special thanks go to Seog-Won Hwang, whose efforts made it possible to keep South Korea in the comparison.

The section of the Barometer survey on young people was done in cooperation with schools in the same way as before. We would like to extend our warmest thanks to the students and teachers of Eurajoen lukio, Lahden yhteiskoulun lukio, Laurin lukio (Salo), Maunulan lukio (Helsinki), Salpauksen lukio (Nastola) and Savonlinnan yhteiskoulun lukio for their excellent cooperation once again.

Pekka Pellinen
Academic Engineers and Architects in Finland TEK

Summary

The strengths of Finland's economic and innovation system have continued to weaken...

Finland's economic and societal development is simultaneously facing cyclical structural difficulties of economic life and the public economy, and difficulties related to the future of the Eurozone. Some positive signs can be seen in these cyclical developments, however, for example in the case of industrial investments, but the necessary structural reforms, especially in the public sector, are advancing slowly.

In previous TEK Technology Barometer comparisons, Finland's strengths have related in particular to the effects of the burgeoning information and knowledge society on the indicators covered in these studies, such as education, techno-scientific knowhow and investments in research and development. The country's economic and societal development would require maintenance and reinforcement of its central strengths. But according to both the 2014 and 2017 Technology Barometers, Finland's position relative to the comparison countries has weakened.

Generally speaking, recent PISA studies suggest that Finland's widely recognised and acknowledged education system is not what it was in earlier years. However, the Technology Barometer shows that relative to the Western comparison countries, our performance has improved. Although the skills of Finnish children and youth basic education have weakened, they are still highly ranked, coming in at fifth place internationally. The main focus area of the 2015 PISA study was the natural sciences, and on that score the skills of Finnish students are deteriorating, both in the natural sciences and in mathematics. In all-round education, Finland is in third place, behind Denmark. South Korea comes first.

Although Finland's position is weaker than before, Finland is still at the top of the list in the indicators that describe techno-scientific skill (the labour force participation rate of those with a college degree, the proportion of the population that has completed a tertiary-level degree, the labour force participation rate of R&D employees, the labour force participation rate of those working in high-technology industry and services, and the proportion of female researchers). To take one example of the downturn, however, the proportion of the entire workforce accounted for by R&D personnel in Finland in the PISA 2014 study is less than in 2010, with Denmark having overtaken in the 2014 study. Participation in life-long learning is at 32 per cent in Denmark, bringing it to second place behind South Korea, with 37 per cent. In 2014, the corresponding figure in Finland was 25 per cent. Measured on the proportion of new degrees in science and technology fields and on the proportion of GDP spent on education, South Korea is number one of all the comparison countries. Measured on the amount of new tertiary-level degrees completed as a proportion of the whole age group, Finland has been dropping since 2010. Similarly, there has been a drop for Finland in the labour force participation rate in high- and mid-high technology industry. In spite of the negative trend, however, Finland is above average for the reference countries in terms of the indicators for the information society for all three indicator groups, namely basic education, general education, and techno-scientific skill.

In investment in private and public-funded R&D and in their share of GDP, Finland is still at a very high level internationally, even though there has been a downturn in both public sector expenditure and R&D industrial spending. The proportion of gross national product on R&D expenditure in Finland has waned continuously since 2009, when it was

3.8 per cent. By 2015 that figure had already dropped to 2.9 per cent, below the target level of 3.0 per cent set in the Europe 2020 strategy. In the comparison of the proportion of GDP, the deduction in GDP expenditure looks less severe than it actually is due to the decrease in GDP. It's also worth noting that the volume of R&D expenditure in Finland on the global scale is extremely small, and for that reason even a small percentage weakening indicates a significant impact on the national economy. The downward trend in research spending, for its part, decreases the country's possibilities for rejuvenating the economy through skill-based structural changes.

The cuts to public R&D financing can be interpreted as partly an indication that the confidence of political decision-makers in the profitability of supporting R&D activity has waned. The 2017 Technology Barometer survey lends support to this view: there is less faith than before among politicians that investing in research will bring large societal benefits.

Worries about the direction that Finland's innovation system is taking clearly rose to the surface in the 2017 Technology Barometer. In the responses to the survey section, TEK members in fact considered research funding inadequate, and they have a more negative view of the situation than the other respondent groups, and than in the previous Barometer. In evaluating the state of science in Finland, their confidence in the country's research activity has also been weakened by the developments of the past few years. In assessing the significance of research insofar as economic and societal development is concerned, the respondents believe that knowledge will be an even more important resource in the future, and as such that investing in it would bring major societal benefits.

... but there are also positive signs

The faith of business leaders in increasing the rate of R&D investments is stronger in the 2017 Technology Barometer than in 2014. Representatives of the business sector indicate that in 2017 they will be investing particularly in product development in computing, communications, environmental and energy technology, and in product development of construction technology. The latter is most likely a response to the many large-scale public infrastructural building projects now underway in Finland.

The proportion of overall service exports accounted for by exports of communications services has helped to keep Finland in first place, and that proportion is even growing. In that light it is easy to agree with the conclusions of a onetime report by the State body the VATT Institute for Economic Research: Those in charge of economic policy must understand that Finland is now a service economy, and that the excessive hankering for an industrialised society will only cripple our development of service expertise and competitiveness. On the international scale, in entrepreneurship Finland is only a mid-level player. The percentage proportion of GDP accounted for by private-sector investments in 2015 was around 20, which puts Finland in joint second place with Germany, behind Sweden. The share of informal investors among the adult population is still low in Finland, especially in comparison with Sweden and the United States, but it has increased somewhat, as has the share of new companies among all the active companies.

Finland's relative positioning in networking and internationality have developed positively. In the 2012–2015 period direct investment in Finland as a proportion of GDP has grown, and this trend has continued in the same vein since 2008. In 2013, Finland was the leading country

among the reference group of countries in terms of attracting foreign R&D investment, with a 0.38 per cent share. In 2013, the Finnish share of GDP accounted for by foreign trade in commodities was 29 per cent. And the same year the country was ranked fourth internationally in openness of services, with a GDP share of 12 per cent.

Development of public-sector productivity is a topical question...

The goal of both the ongoing social welfare and health care reform programme (SOTE) and the municipal reforms is to make social and health care services in Finland more efficient and more effective. In relation to these topical reforms, politicians this time round also placed high priority on increasing the productivity of the public sector. As in the previous Barometer, over 80 per cent of Finnish politicians who responded to the survey believed that the most effective way of improving public-sector productivity was to remove barriers between different administrative areas and to improve co-operation between them. In a knowledge-based society, the development of digitalisation makes possible increased public-sector productivity. Indeed, almost 70 per cent of politicians believe that the best way to make progress towards the aforementioned goal is to increase the use of information technology and electronic services in public services. Only 30 per cent of politicians considered reducing the number of municipalities through incorporation an effective means of raising public-sector productivity.

... that has ties to social cohesion

On measures related to sustainable development of societal equality (the health of the population, income distribution, gender equality), the leading country in previous Technology Barometers was Sweden. That has not changed, but now Sweden's leading position has weakened somewhat from the last measurement. Development of the public sector has a close connection with the development of social cohesion, and in this regard Finland's situation has deteriorated, with the country now being below the average. The major reason for this is increased unemployment: at 9.4 perc ent, the unemployment rate in Finland is now the highest among the reference group of countries. The proportion of long-term unemployed in Finland has grown simultaneously with the growth in the overall unemployment rate. That is, the number of long-term unemployed has increased faster than cyclical unemployment has grown. The proportion of young unemployed in Finland has also grown, even if the statistical data on different countries aren't always entirely accurate. The Finnish population's life expectancy in particular is still clearly below the majority of the countries being compared for both men and women.

Some perspective on Denmark's development

Denmark offers interesting perspectives in the Technology Barometer for many of the developments currently underway in Finland. Amongst other things, Denmark has overtaken Finland in the proportion of R&D personnel that account for the entire workforce, making Denmark the international leader on this indicator. One measure of this is that Denmark has applied for more patents from the European Patents Office in the 2009–2013 period than any other European country. And in 2015, more scientific articles were published in Denmark per thousand citizens than in any of the reference countries. The growth rate of scientific publication was also faster than in any of the reference countries. In the past few years, Denmark has implemented several interesting reforms in education, research and innovations policy, and these go some way to explaining the country's positive performance on many measures of development.

A clear drop behind us, some light ahead

The latest Technology Barometer results make clear in a concrete, and even alarming way just how negative the development has been in Finland in expertise-based activities in many areas. In some respects, it might not even be too much of an exaggeration to speak of a collapse of standards, particularly in investment in R&D. On the other hand, there is also some budding promise in coming developments. For example, companies' estimates of their own upcoming R&D investment are on the increase.

In previous Technology Barometers, Finland's chronic problems, low levels of networking and internationality and the level of foreign investments in the country, have begun to improve a bit. In recent years there have been encouraging signs in this direction. Even though part of the investments are linked to transfer of holdings abroad, in many cases international actors have also opened the way for considerable business opportunities. Especially notable in this regard is the amount of international investments that have been aimed at expertise-based, R&D-intensive companies whose activities in Finland are continuing, and often even expanding. This is a strong signal to decision-makers: previous investments in knowledge have created expertise that commands a high price on international markets. So continuing to invest in expertise makes very good sense.

Where exactly did the faith in innovation-driven economic growth disappear to?

Finland is one of the few OECD countries in which the real investment in R&D has been on a downward slide for some time now. Business sector investments have fallen sharply since 2009. The profitability of companies has been maintained by staff layoffs and cuts in expenses, and simultaneously there have been fewer investments in creating new openings. Most of the current development investments are directed at continuing development of existing products, rather than at creating anything genuinely new (source: Enterprise Finland, 2015). State investment in innovation has slumped continuously since 2011. Finland is therefore lagging behind on the research and innovation activity front, and the consequences are showing up clearly in our competitiveness. At the same time, the Barometer's questionnaire shows that the political decision-makers' view of the value of R&D activity is falling away. In this light, it has to be asked, what happened to faith in innovation-driven economic growth?

Finland has traditionally had an excellent understanding and appreciation of the mechanisms of innovation-driven economic prosperity. The country's steep climb out of the 1990s recession was almost totally due to taking advantage of technological expertise. Both the events of recent years and the Barometer's findings suggest that these lessons have been forgotten to some extent. Is there a sufficient understanding of cause-and-effect relations anymore? Or is it simply a question of ignorance?

Economic growth is brought about through increasing the amount of work, new foreign investments, and increased productivity. Increased productivity is very largely made reality by development work and innovation. Economist Robert Solow, winner of the Nobel Memorial Prize in Economic Sciences in 1987, has shown that the vast majority of economic growth in developed Western economies is due to precisely these factors. And work productivity is the most important background factor for long-term growth. In the public discussions of recent years on competitiveness, the talk has been almost exclusively of salary costs, although productivity is a far more relevant matter to be concerned with. Competitiveness built on sustainable grounds is above all a result of innovation.

Is that likely to change?

The continuing cuts have weakened the preconditions for growth in Finland. Public investments in research and development are crucial for economic renewal and development of productivity. Lamentably, the cuts in public funding have had a particularly heavy impact on applied R&D activity: the reduction in financing through Enterprise Finland

of around a quarter of the total is unprecedented among investments in the future. On the other hand, an entirely positive message is to be found in the latest barometer survey too, in that Finnish companies are now moving towards increasing their investments in R&D. This seed of promise after the prolonged low cycle could be fostered by encouraging greater risk-taking through increased funding to Enterprise Finland and the VTT Technical Research Centre of Finland for projects that bring about structural reforms. In this way the public sector could lower the risk-taking threshold for others, and bring about the long-awaited upturn that the country is sorely in need of.

Digilisation is one of the most important trends of change that affect society and business activity. Its consequences, particularly on work productivity, are extremely significant. Despite a good headstart, progress in this direction in Finland has been unimpressive. In the public sector, actors in the various administrative areas need better coordination in creating the basic structures for a digital society, especially in the social welfare and health care sector and in the nationwide service architecture, in the industrial internet, and in fifth-generation technologies.

The needed return to the path of growth after our recent wanderings demands from our decision-makers a clearer vision of the role of innovation-based economic growth, and more ambition. What is needed from the state authorities is a cross-administrative approach that concentrates on competitiveness, creating value, and developing productivity. In the private sector, what is most fundamental is to strive for increased growth and risk-taking ability. The public sector can help in this by creating models of action in which the public contribution leverages private money in investment in expertise and new initiatives. Paradoxically, many of the cuts to public funding of recent years have been aimed at forms of activity that have been performing the best, at the same time as ineffective and even harmful forms of public support are carrying on more or less as before (VATT Institute for Economic Research 2013, Ministry of Economic Affairs and Employment, 2014). The public debate has not been sufficiently attentive to the vast differences in efficacy of these various instruments.

Tax deductions for company R&D were tried out in Finland a few years back. If there were the will to give it another try, it would be a good idea to investigate the possibilities for adopting an incremental deduction model in the same context. The model would limit benefits only to increases in R&D investments, and so would create an extremely powerful incentive.

In the new Barometer, one of the things that is doing most to weaken Finland's position is long-term unemployment. With the current situation, new jobs are being created mostly in expertise-based companies in the small and medium-sized enterprise (SME) sector. From this perspective also it is of the utmost importance to boost innovation activity and growth-seeking business activity. The problem of long-term unemployment has spread to affect even more sectors of the population, which makes completely new solution models all the more urgent to create. By intensifying co-operation between different administrative areas, it is possible to relieve the current incidence problem of the labour force. For instance, one of the most innovative operations models (Digiboost) in innovation management could well be added to the range of tools available to workforce administration.

But instead of this, the debate on innovation activity has for the most part been very organisation-centred. The ability of organisations to create innovations, however, is ultimately dependent on whatever abilities are present, or not, at the individual level. The readiness of individuals for innovation and the development of these innovations should receive far more scrutiny.

Denmark's employment model and the changes that have been made to it have attracted some discussion in Finland recently. Based on the results of the new Barometer, Denmark has improved its standing also on many measures of innovation activity productivity. Aside from job-creation measures, it would be wise too to increasingly focus on the improvements that Denmark has made in improving capacities for putting innovation into practice.

Introduction

The Technology Barometer assesses the performance of Finland's economy and society insofar as it is based on techno-scientific skill and development.

The indicator-based section of the **Technology Barometer** compares Finland's development to that of selected reference countries. The survey section of the Barometer maps out the various demographic groups' values, attitudes, and views as well as their observable changes. The indicator section's individual and combined indicators have been assembled under four thematic areas. Each of these depicts the typical phases of development or transition in a modern society: *from an information society to a knowledge society, followed by a knowledge-value society, and ending up with a society based on sustainable development.*[1] For the most part, the barometer's survey section is similar to the indicator section structure and provides future-oriented views on societal development.

The purpose of the Technology Barometer is to strengthen the knowledge base for competence development, to promote and improve related societal debate, and to use this knowledge and debate to support decision-making on the allocation of education and research resources within public administration and economic life. In terms of Finland's future competitiveness, the key issues consist of deciding upon the nation's orientation on various technologies, competence, related priorities, and resource allocation.

The barometer's indicator section uses a model that has been formulated based on economic, innovation-related and social theories of development. The indicator-based data can be used for the generation of index figures to display the nation's techno-scientific state and level of societal development in comparison to the reference group. The reference group consists of Sweden, Denmark, the Netherlands, Germany, the United Kingdom, the United States, and Japan. And included for the second time in the Technology Barometer's indicator comparisons is South Korea.

The target group enquiries are used to measure various demographic groups' values, attitudes and views on techno-scientific development and its various factors, as well as the position, state and level and effects of scientific-technological research in Finland. The information which is obtained from target group enquiries can be used to explain the results of indicator-based comparisons, so as to understand the underlying reasons for the nation's current state of scientific-technological development. The survey section combines indicator-based data with detailed supplementary data on citizens' underlying values and attitudes. The target groups for the survey are members of Academic Engineers and Architects of

[1] Composite indicators for information society, knowledge society, knowledge value society and society based on sustainable development are developed and produced by Academic Engineers and Architects in Finland TEK together with the VTT Technical Research Centre of Finland (the background and structure of the Technology Barometer are described in more detail in Chapter 4).

Finland TEK, young people studying at upper secondary level, as well as political and business decision-makers. The survey complements and diversifies the indicator comparison results through comparing the four respondent groups' views and the technology barometer results.

This time a number of changes have been made to the structure of the Technology Barometer. First off, the central results are now summarised at the beginning of the report. After this introductory chapter, Section 2.1 presents the central results of indicator study, and Section 2.2. presents developments in Denmark. In the 2017 Barometer our Nordic neighbour is the special focus of comparison, as South Korea was in the 2014 Barometer. Unlike in previous Barometers, in the present report indicator data and survey results are presented in less detail. However, in the 2017 Technology Barometer the results and interpretations are more strongly focused than before on those indicators and survey responses that have shown the most significant changes relative to either previous Barometers, or to other similar comparative studies. This changed approached has resulted in four theme areas being brought to the fore in the present study: development of information society (Section 3.1), especially development concerning education standards, development of the knowledge society (Section 3.2), especially investments in research and product development, development of the knowledge-value society (Section 3.3), especially patents, export of services, networking and internationalisation), and sustainable social development (Section 2.4), especially development relating to employment. All the Technology Barometer's results graphs, indicator study diagrams, and country graphs and charts are to be found in Appendices 1, 2 and 3, respectively.

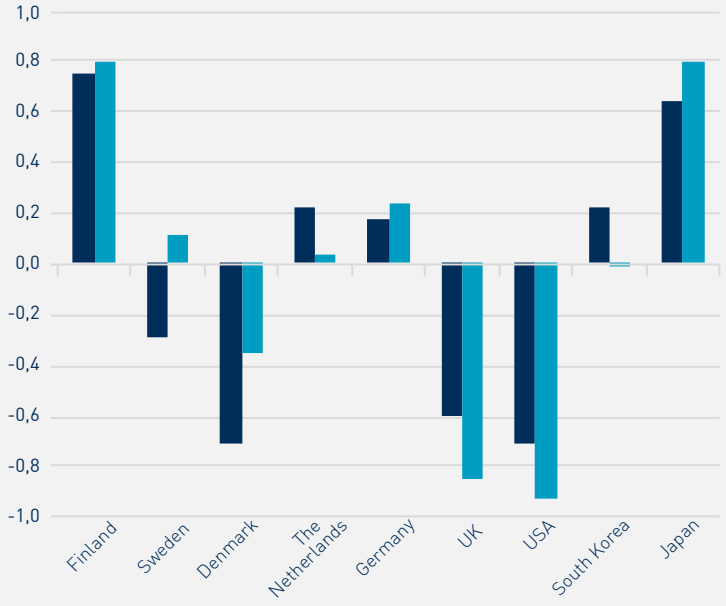
2 INDICATOR COMPARISONS 2016 MAIN RESULTS

2 INDICATOR COMPARISONS 2016 MAIN RESULTS

2.1 Key results and interpretations of the indicator comparisons

The key results from the Technology Barometer indicator comparisons are presented in the figures below. Indicators 1.19, 2.29, 3.27 and 4.36 depict the countries' ratings in four thematic areas describing the typical features and development dimensions of a modern society. We call these the information society, knowledge society, knowledge-value society, and society based on sustainable development. As in the 2014 Technology Barometer, South Korea is included, and in the following will be examined separately also. The development of GDP has slowed down in Finland and some of the reference countries, and this must be taken into account in the indicators in which development is compared to GDP.

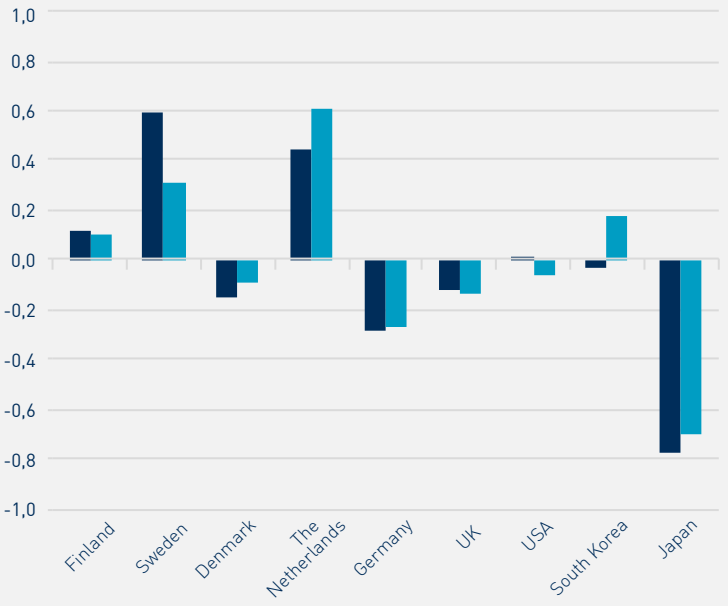
Indicators 1.19, 2.29, 3.27 and 4.36. The reference group countries' proportional ratings in accordance with indices describing the properties and development dimensions of information society, knowledge society, knowledge-value society and society based on sustainable development.



INDICATOR 1.19.

Relative ranking of the comparison countries on basic education, all-round education and skill, and scientific-technological skill, overall indicator

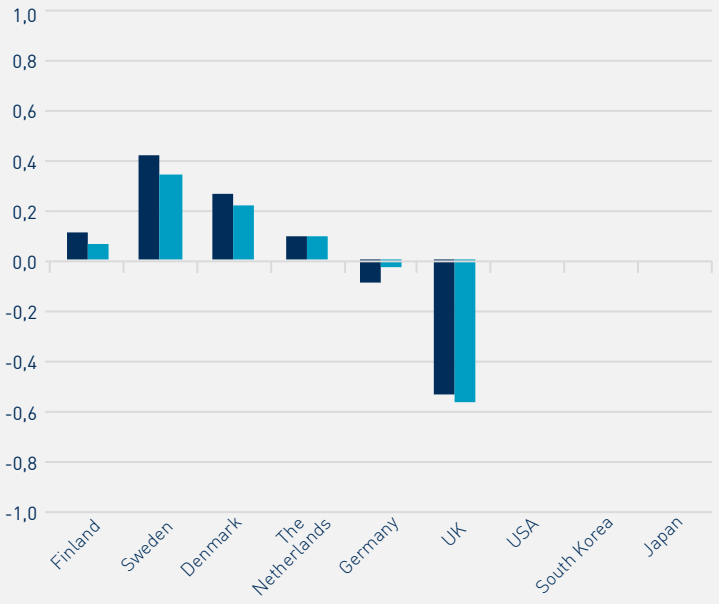
- TECHBaro 2014
- TECHBaro 2016



INDICATOR 3.27.

Relative ranking of the comparison countries on comprehension and management of information, entrepreneurship, regeneration of the economy, and networking and internationality, overall index.

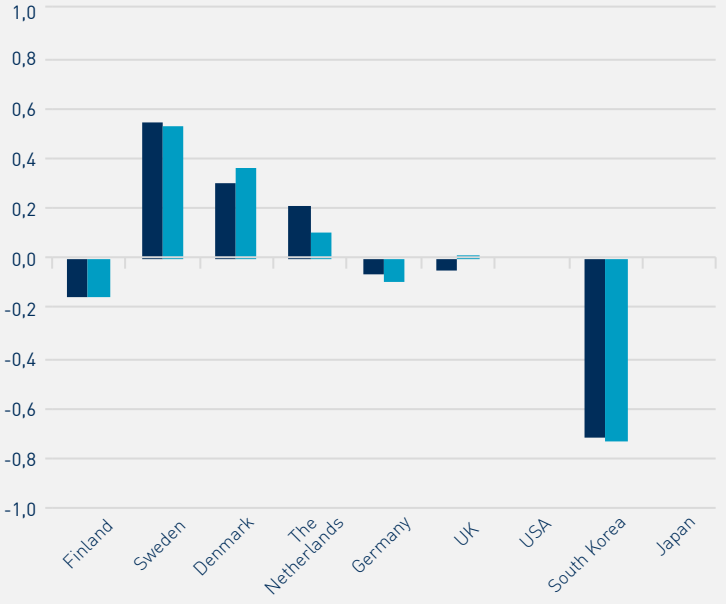
- TECHBaro 2014
- TECHBaro 2016



INDICATOR 2.29.

Relative ranking of the comparison countries on investments and product development, information and communications technology, and application of new knowledge, overall indicator.

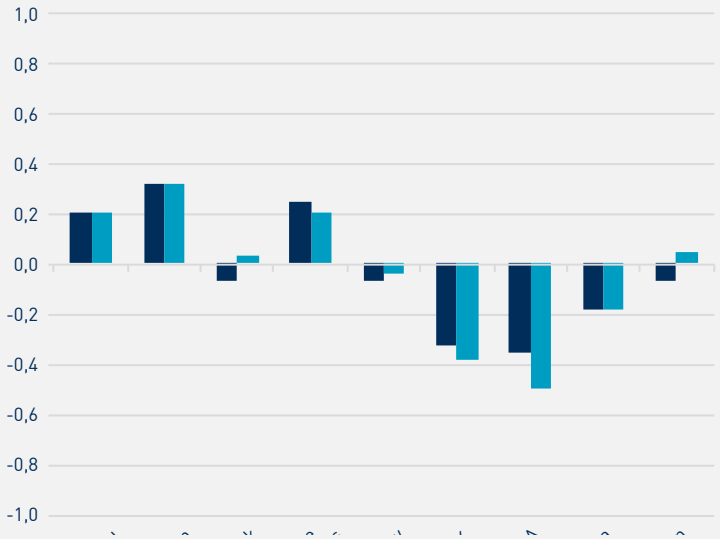
- TECHBaro 2014
- TECHBaro 2016



INDICATOR 4.36.

Relative ranking of the comparison countries on citizens' health, income distribution, employment, equality between the sexes, environmental protection and the state of the environment, overall indicator.

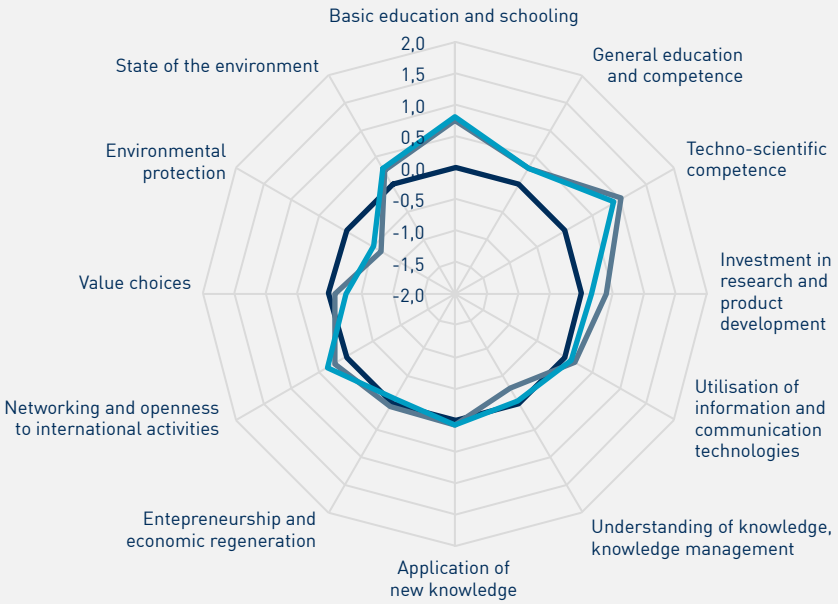
- TECHBaro 2014
- TECHBaro 2016



OVERALL INDEX.

The reference group countries' proportional ratings in accordance with the indices describing the properties and development dimensions of information society, knowledge society, knowledge-value society and society based on sustainable development.

TECHBaro 2014
TECHBaro 2016



COUNTRY GRAPH 1.

Finland's strengths and weaknesses in comparison to the reference group countries.

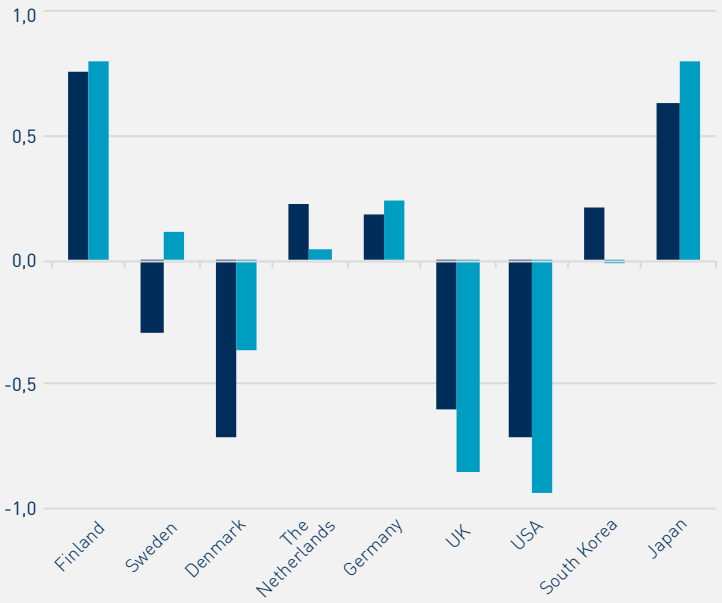
AVERAGE
TECHBaro 2014
TECHBaro 2016

Overall index Relative ranking of the comparison countries on information, knowledge, knowledge-value and sustainable social development based on the respective indicators.

Country graph 1. Finland's strengths and weaknesses in comparison to the reference group countries. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative the country's achievements are below average.

Of the information society indicators, in basic education Finland is still strongly placed, but the direction of development is downward. In all-round education, Finland is in third place, behind Denmark. South Korea comes first. In techno-scientific skill Finland still comes first, but here too things are deteriorating. South Korea's low proportion of female researchers lowers its ranking. Denmark's ranking in techno-scientific skill has improved from the previous measurement, and the country is now in second place. Participation in life-long learning is at 32 per cent in Denmark, bringing it to second place behind South Korea, with 37 per cent. In 2014, the corresponding figure in Finland was 25 per cent. Measured on the amount of new tertiary-level degrees completed as a proportion of the whole age group, Finland has been dropping since 2010. Similarly, there has been a drop for Finland in the labour force participation rate in high- and mid-high technology industry. In spite of the negative trend, however, Finland is above average for the reference countries in terms of the indicators for the information society for all three indicator groups, namely basic education, general education, and techno-scientific skill.

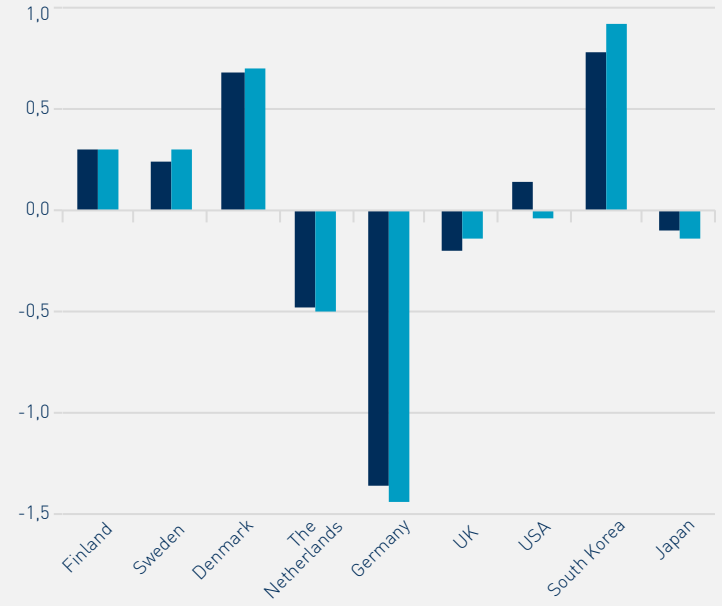
Indicators 1.16 and 1.17. Relative ranking of the comparison countries on all-round education and competence measured by the proportion of GDP spent on education, student/teacher ratio, proportion of the population with a college degree, and on indicators of life-long learning.



INDICATOR 1.16.

Relative ranking of the comparison countries on basic eduction based on the PISA study and on the student/teacher ratio.

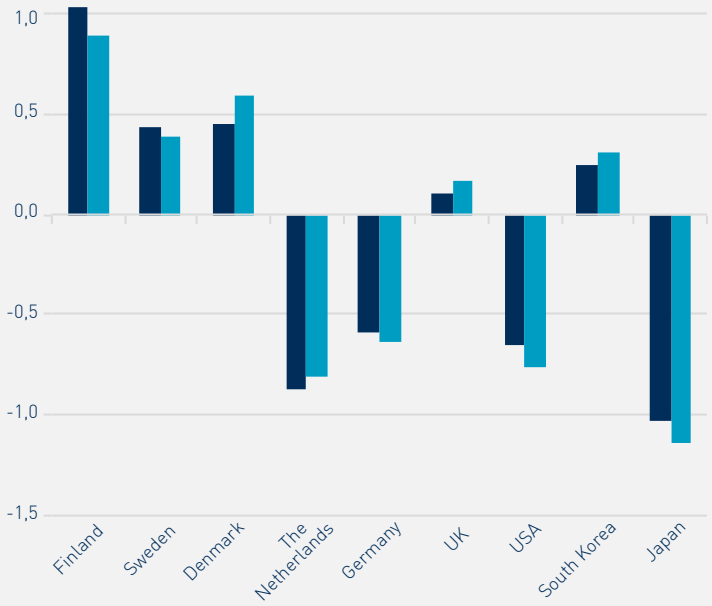
TECHBaro2014
TECHBaro2016



INDICATOR 1.17.

Relative ranking of the comparison countries on all-round education and competence measured by the proportion of GDP spent on education, on the proportion of the population with a college degree, and on indicators of life-long learning.

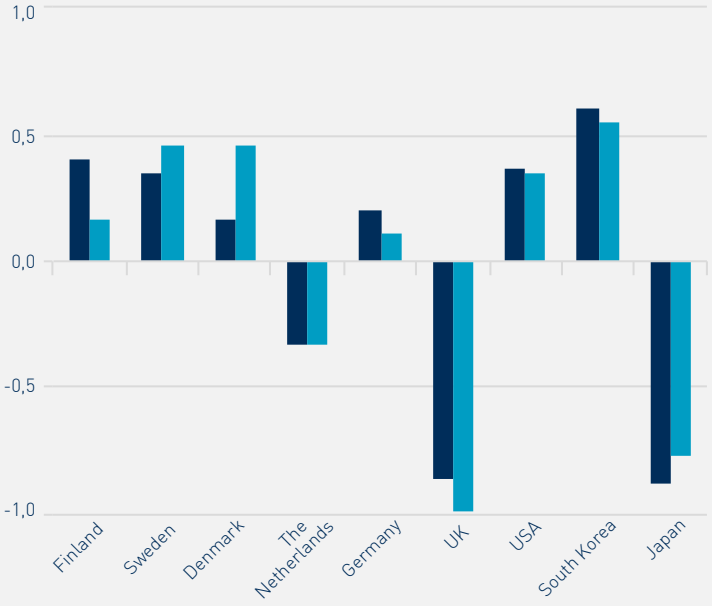
TECHBaro2014
TECHBaro2016



INDICATOR 1.18.

Relative ranking of the comparison countries on scientific-technological competence measured as a proportion of the labour force with a college degree, the proportion that has completed a tertiary-level degree, the proportion of the labour force accounted for by employees in advanced-technology industry, services, and R&D personnel, and the proportion of researchers that are female.

TECHBaro 2014
TECHBaro 2016



INDICATOR 2.26.

Relative ranking of the comparison countries on investments in research and product development measured by public and private R&D expenditure as a proportion of GDP, and by R&D expenditure as a proportion of public financing.

TECHBaro2014
TECHBaro2016

Indicator 1.18. Relative ranking of the comparison countries on techno-scientific competence measured as a proportion of the labour force with a college degree, the proportion that has completed a tertiary-level degree, the proportion of the labour force accounted for by employees in advanced-technology industry, services, and R&D personnel, and the proportion of researchers that are female.

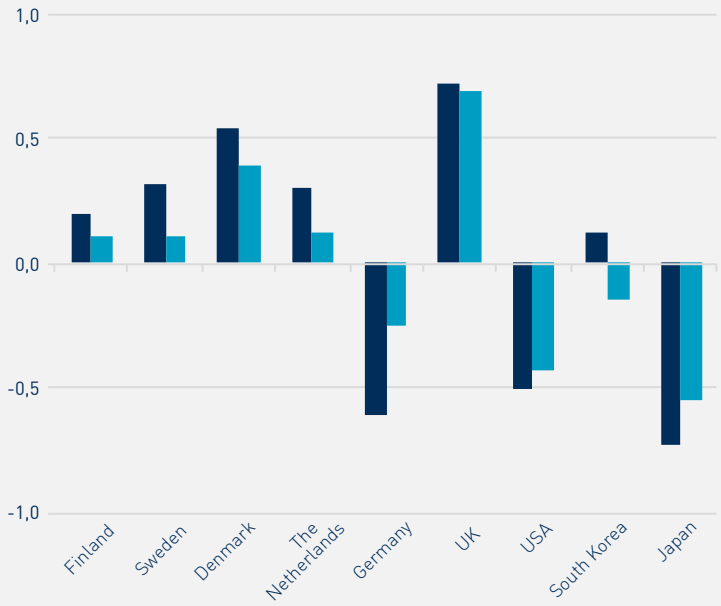
Of the information society indicators in investment in research and product development, Finland has dropped to fifth place after (in decreasing order) South Korea, Sweden, Denmark, and the United States. In use of information and communications technology, Finland is in third place behind the United Kingdom and Denmark. Prevalence of mobile broadband among the total population has grown markedly in Finland. And Sweden, for its part, has invested more in fixed availability of at least 100 Mbps. The largest proportion of broadband connections of households is in Denmark, the Netherlands, and South Korea. Prevalence of mobile broadband of at least 10 Mbps among the total population is largest in South Korea. The rate of use of the internet among the entire population is especially high in all the reference countries. Denmark, Sweden and Finland are in the lead here. The proportion of SMEs involved in innovation activity is highest in Germany, whereas the proportion of innovation cooperation is highest in Denmark. On the knowledge society indicator groups, Finland is above average in R&D investments, slightly above average in the use of ICT, but slightly below average in application of new knowledge, i.e. in innovation activity.

Indicator 2.26. Relative ranking of the comparison countries on investments in research and product development measured by public and private R&D expenditure as a proportion of GDP, and by R&D expenditure as a proportion of public financing.

Indicators 2.27 and 2.28. Relative ranking of the comparison countries on application of new information measured by the proportion of SMEs of companies that have received public R&D funding, the proportion of SMEs engaged in innovation activities of all companies, and the share of SMEs engaged in innovation cooperation of innovative SMEs.

Of the knowledge-value society indicators in comprehension and management of knowledge, as seen for instance in amount of PCT and EPO patent applications per million residents, Finnish is average. Korea has a clear lead. In patents granted by the United States Patent and Trademark Office per million residents, the United States itself, Japan, and South Korea are at a markedly higher level than the other reference countries. Scientific publication scientific publication amount per thousand residents is highest in Denmark, Sweden, Finland, and the Netherlands. In gross domestic production per hours worked, South Korea is clearly in the lead. There is no data available here on the United States or Japan. In the proportion of GDP accounted for by high- and mid-high technology value-added, Finland has fallen quickly, as is the case also in the proportion of GDP accounted for by high-technology fields.

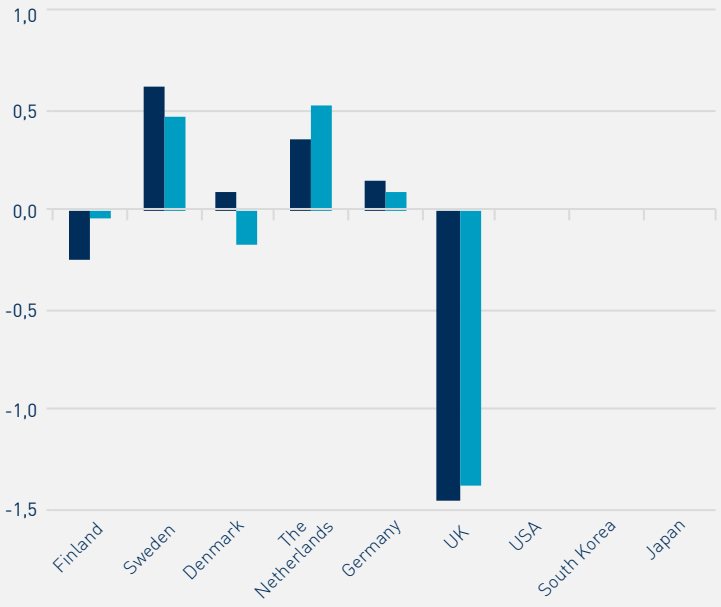
In the proportion of industrial production exports accounted for by high technology, South Korea is in a class of its own. The proportion of overall service exports accounted for by exports of communications services has helped to keep Finland in first place, and that proportion is even growing. On the international scale, in entrepreneurship Finland is only a mid-level player. In entrepreneurial activity (% of the adult population) Finland is fifth after the United States, South Korea, the Netherlands, and Sweden. On the proportion of informal investors in the adult population, however, Finland is far behind the United States and Sweden. Using the proportion of GDP accounted for



INDICATOR 2.27.

Relative ranking of the comparison countries on information and communications technology measured by communications technology expenditure as a proportion of GDP, of information and communications technology use, and of electronic business transactions. Also included is the prevalence of both mobile and fixed broadband internet connections, and the proportion of internet traffic through secure servers.

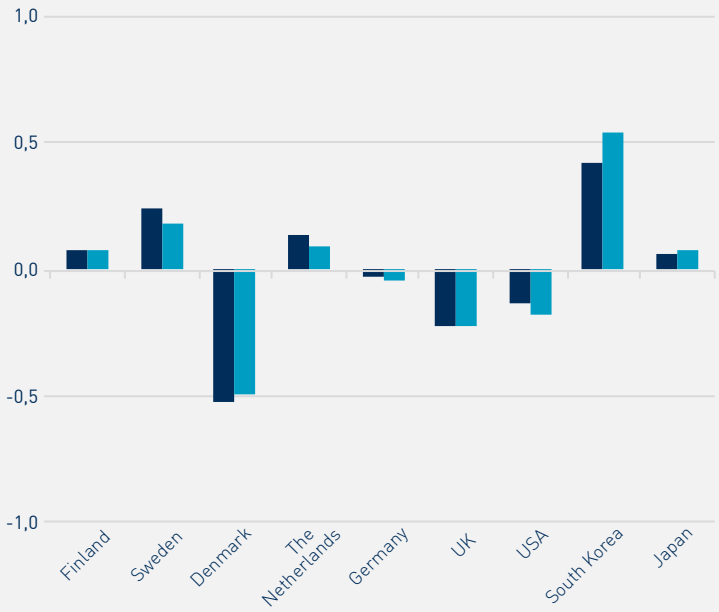
TECHBaro2014
TECHBaro2016



INDICATOR 2.28.

Relative ranking of the comparison countries on application of new information measured by the proportion of SMEs of companies that have received public R&D funding, the proportion of SMEs engaged in innovation activities of all companies, and the share of SMEs engaged in innovation cooperation of innovative SMEs.

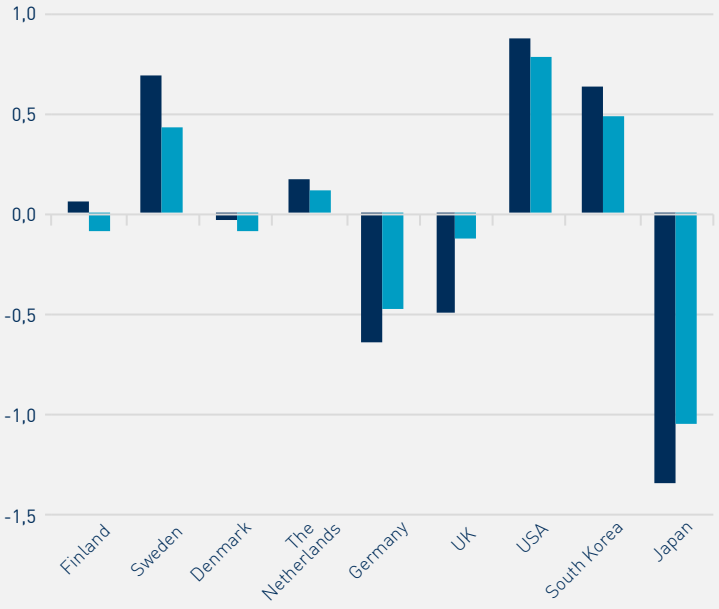
TECHBaro2014
TECHBaro2016



INDICATOR 3.24.

Relative ranking of the comparison countries on comprehension and management of information measured by the proportion of GDP that is accounted for by expenditure on patents and scientific articles, work productivity, manufacturing and export of advanced technology, information and telecommunication technology (ICT) services, and high- and medium-high-technology fields.

TECHBaro2014
TECHBaro2016



INDICATOR 3.25.

Relative ranking of the comparison countries on entrepreneurship and economic regeneration measured by the proportion of GDP accounted for by business capital investments, by the proportion of new businesses, the proportion of informal investors, and the degree of investment in the private sector.

TECHBaro2014
TECHBaro2016

by direct investments in networking and internationality, Finland is on the same level as Sweden and Denmark, but clearly behind the Netherlands. Measured by share of GDG accounted for by inbound and outbound direct foreign investments, Netherlands is clearly first. Openness to international trade in commodities is highest in the Netherlands, and openness to international trade in services is highest in Denmark. According to the knowledge-value society group of indicators, then, Finland is about average compared to the reference group of countries, but has however slightly improved its placing in networking and internationality.

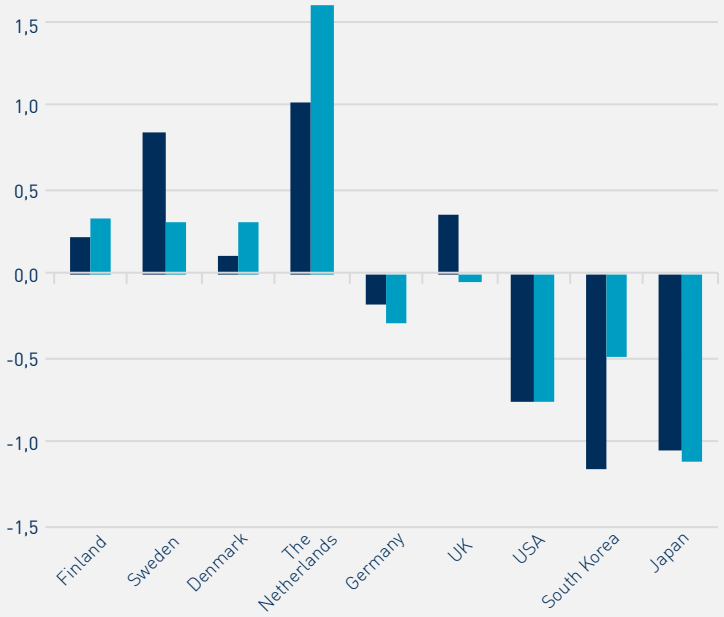
Indicators 3.24 and 3.25. Relative ranking of the comparison countries on comprehension and management of information measured by the proportion of GDP that is accounted for by expenditure on patents and scientific articles, work productivity, manufacturing and export of advanced technology, information and telecommunication technology (ICT) services, and high- and medium-high-technology fields.

Indicator 3.26. Relative ranking of the comparison countries on networking and internationality measured by the proportion of GDP accounted for by foreign direct investments, the proportion of GDP accounted for by foreign financing in R&D in the business sector, and by the openness of trade.

In measuring ecologically and socially sustainable development, Finland is below average among the reference countries in the overall indicator set. In the combined indicators on health of the population, employment rate and equality between the sexes, Sweden has the lead. Here Finland has dropped to the tail end of the reference countries. This results above all from increased unemployment. Above all, the proportion of youth unemployment and long-term unemployment in Finland has grown, whereas in comparison countries it has either decreased or stayed the same. Apart from Finland, only in the Netherlands has the proportion of long-term unemployment clearly increased. In healthy life expectancy, Finland is at the bottom, as in the previous measurements.

Finland's placing in environmental protection is explained by high energy-intensity. The proportion of greenhouse gas emissions per person and relative to GDP have clearly fallen in Finland. The condition of the environment is measured by, amongst other indicators, the amount of sulphur and nitrogen oxides, which lower air quality, and the proportion of volatile organic compounds as a proportion of GDP, and the proportion of health risks resulting from impurities in air and water. The amounts of sulphur and nitrogenous oxide emissions as a proportion of GDP have dropped noticeably. The risk to health by airborne and water-borne impurities, and risk to health posed by microscopic particles, are lower in Finland than in all the comparison countries.

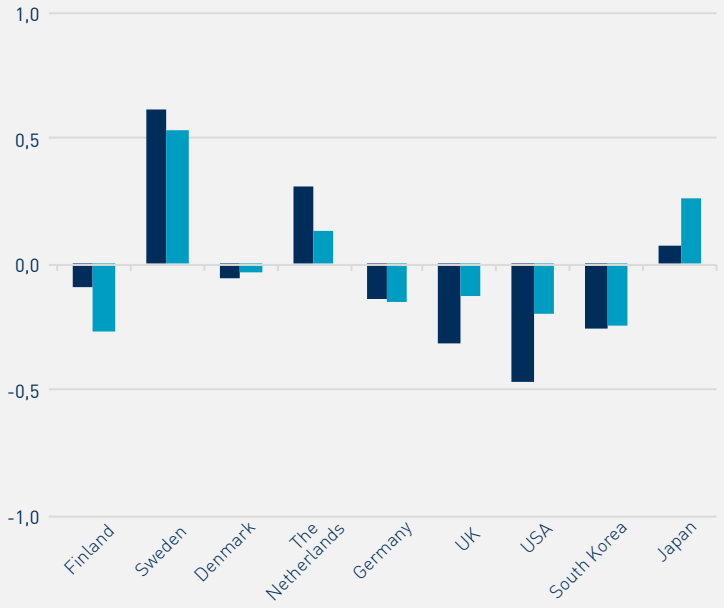
Indicator 4.33. Relative ranking of the comparison countries on citizens' health, income distribution, employment rate, and equality between the sexes.



INDICATOR 3.26.

Relative ranking of the comparison countries on networking and internationality measured by the proportion of GDP accounted for by foreign direct investments, the proportion of GDP accounted for by foreign financing in R&D in the business sector, and by the openness of trade.

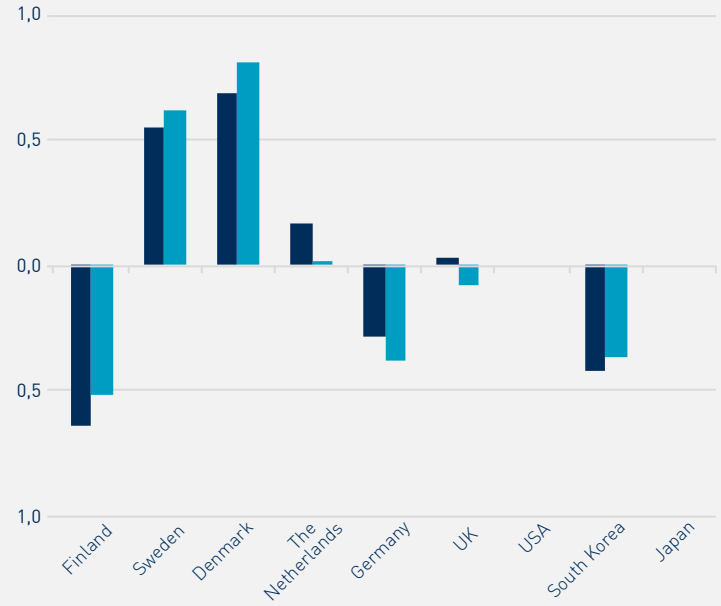
TECHBaro2014
TECHBaro2016



INDICATOR 4.33.

Relative ranking of the comparison countries on citizens' health, income distribution, employment rate, and equality between the sexes.

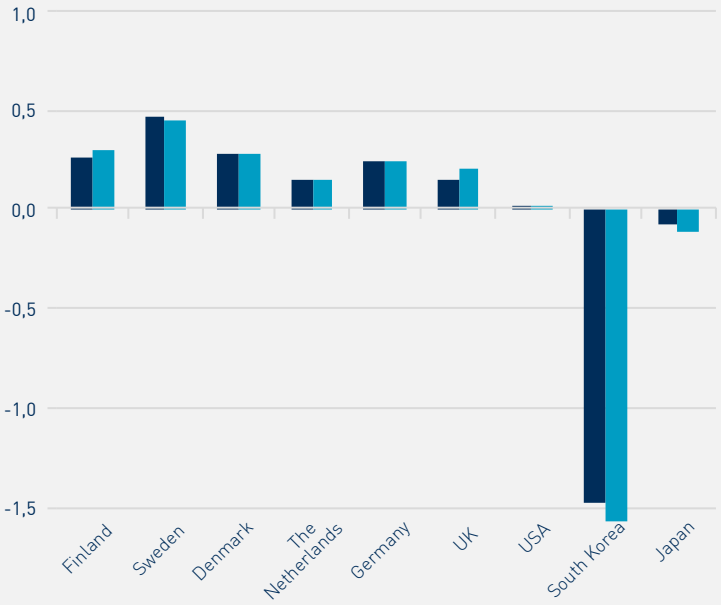
TECHBaro2014
TECHBaro2016



INDICATOR 4.34.

Relative ranking of the comparison countries on environmental protection measured by the proportion of total energy production accounted for by environmental protection expenditure, greenhouse gas emissions, energy intensity, and renewable energy sources.

- TECHBaro2014
- TECHBaro2016



INDICATOR 4.35.

Relative ranking of the comparison countries on the state of the environment measured by the proportion of GDP accounted for by sulfur oxides, oxides of nitrogen, and volatile organic compound emissions, by impurities in the water and air, by protected land and marine areas, and by the habitats of animal species.

- TECHBaro2014
- TECHBaro2016

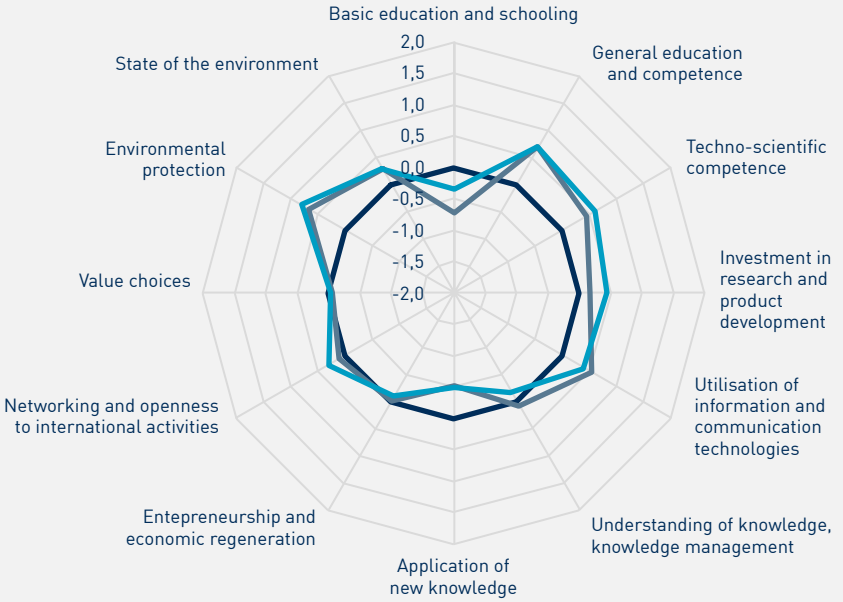
Indicators 4.34 and 4.35. Relative ranking of the comparison countries on the state of the environment measured by expenditure on environmental protection, proportion or greenhouse gases, energy-intensive and renewable energy production, the proportion of GDP accounted for by sulphur oxides, oxides of nitrogen and volatile organic compound emissions, by impurities in the water and air, by protected land and marine areas, and by the habitats of animal species.

2.2 Denmark's development can be useful to Finland

Denmark offers interesting perspectives in the Technology Barometer for many of the developments currently underway in Finland. In comparing Finland and Denmark to each other the differences in industrial structure between the two must be taken into account: In Denmark, the foodstuffs and pharmaceuticals industries have a larger role, and in Finland the forestry, metals and electronics industries are dominant.[2]

Denmark has invested heavily in recent years in techno-scientific expertise, research and product development, whereas Finland's position in these areas has weakened. Finland has dropped here from second place to joint fourth position with the United States. Denmark shares second place with Sweden. Relative to the previous measurement, Denmark has most improved its position in R&D investments. The proportion of education expenditure as a proportion of gross domestic product is greatest among the reference countries in Denmark, and participation in lifelong learning is second-highest there, after South Korea. Denmark has overtaken Finland in the amount of research and development personnel as a proportion of the overall workforce, and on that score is now the leading country. Denmark is also the clear leader per capita in scientific publications.

Country graph 3. Finland's strengths and weaknesses in comparison to the reference group countries. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative the country's achievements are below average.



COUNTRY GRAPH 3.

Denmark's strengths and weaknesses in comparison to the reference group countries.

[2] Tanskan tutkimus- ja innovaatiojärjestelmän sekä niitä koskevan politiikan kuvaus perustuu paljolti professori Carter Blochin (Department of Political Science - Danish Centre for Studies in Research and Research Policy, Aarhus University, Denmark) esitelmään Innomitta-projektin 2. työpajassa 15.11.2016 VTT:llä Espoossa.

Denmark applied for patents from the European Patents Office (EPO) in the 2009–2013 period at a faster rate than any other European country. In 2015, the number of scientific articles per one thousand inhabitants was highest in Denmark, and actual number of articles also grew faster than in comparison countries. It is notable that the trend towards increasing the value of high-technology production as a proportion of GDP is clearly growing in Denmark, whereas in the other comparison countries it is decreasing. Excluding Denmark, the proportion of exports accounted for by high-technology production has decreased in all the reference countries, which also contributes to Denmark's strengthened position in innovation activity. Participation in life-long learning is at 32 per cent in Denmark, bringing it to second place in the comparison countries behind South Korea, with 37 per cent. In the past few years Denmark has implemented several interesting reforms in education, research and innovations policy, and these go some way to explaining the country's impressive performance on many measures of development.

Denmark's innovation system was renewed in the 1990s, when the Danish National Research Foundation was established to support long-term research work. Around the same time the number of doctoral student positions in the country was tripled, and more autonomy was given to colleges and universities. At the same time, the division of research funding into institutional funding and competitive project funding was frozen to the early-1990s level. Doctoral training was emphasised in fields that were believed to be most important for economic growth, namely medicine and the natural and engineering sciences.

In the 2000s, the emphasis of research activity in Denmark shifted increasingly from fundamental research activity to strategic research. In other words, research funding was aimed at producing commercial success, innovations. Amongst other institutions that were founded to this end were the Danish Council for Technology and Innovation, the Danish Council for Strategic Research, and the Danish National Advanced Technology Foundation. At the same time, research funding was changed in such a way that the emphasis shifted from institutional funding to project funding, and from funding many small projects to funding fewer, bigger projects. From 2006 on, these changes accelerated the growth of R&D investments to a significant degree.

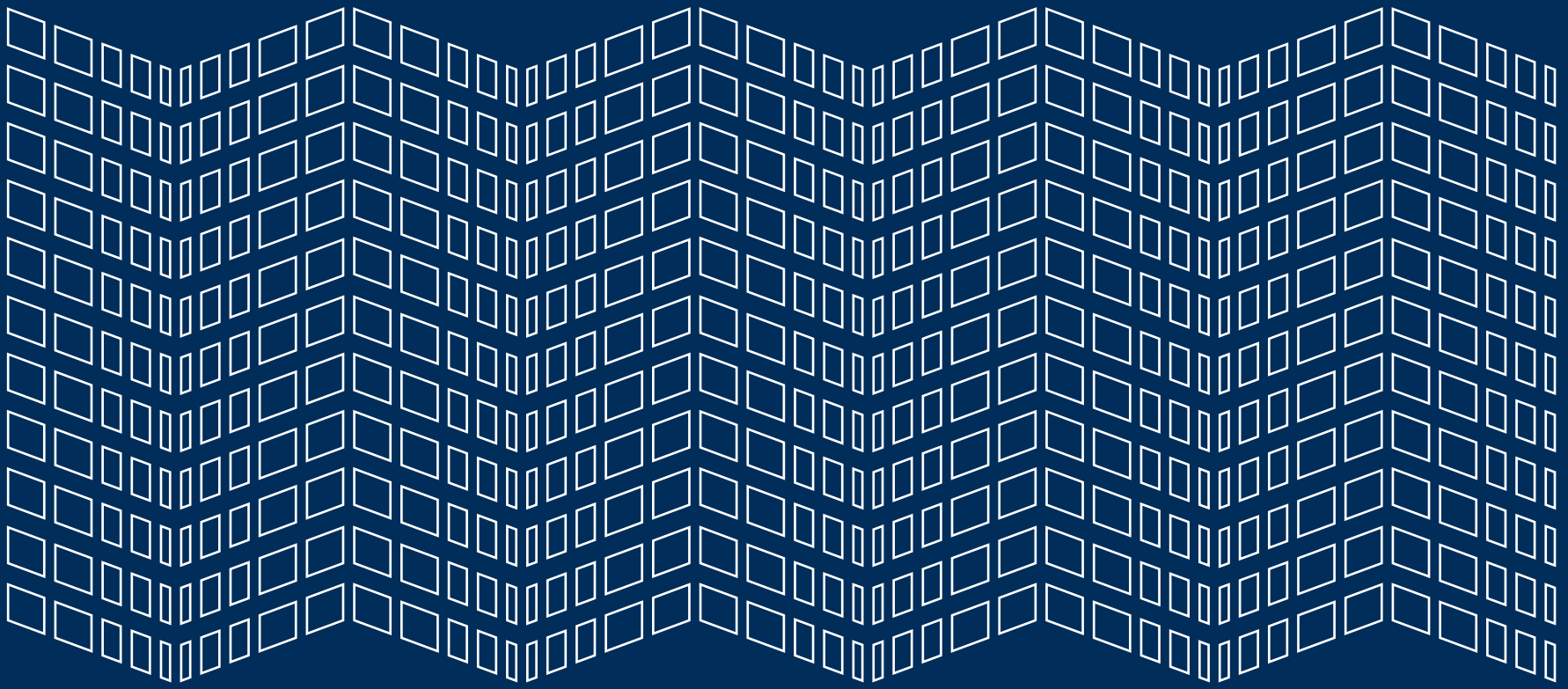
Prior to that, in 2003, the country's new university law underscored the role of the government as the most important decision-maker in university affairs. One requirement of the new law was that the majority of the membership of university boards of management had to come from outside the university system. The law emphasised that the new administrations of the universities would have to make strategic choices and to prioritise their areas of focus in research. Structural reforms were implemented in connection with the merger process, which reduced the number of universities in Denmark from twelve to eight. In the same way, twelve of the fifteen strategic research institutes were transferred to the remaining twelve universities. As a result of the change, resources were concentrated on a few selected departments, and there came a clear change in the division of labour between more research-oriented university work and more applied research institute work. In practice most of the research institute sector was shut down (Aagaard, 2011).

In the Danish innovation strategy published in 2012, the chosen focal points were, in common with many other EU countries, societal problems and socioeconomic effects, education and the creation of value based on expertise. Although industrial difficulties were emphasised less, from 2012 on the emphasis in development of the country's industry has been on creating more employment with the aid of technological and research development, and of new business models and production systems (automation and digitalisation).

Denmark has established new organisations and programmes for promoting innovation activity. In 2014, three funds were joined together to form the new Innovation Fund Denmark. The procedures of the new fund were simplified, as were its financial instruments, and more attention was given to the entire value chain of the innovation process. The targets of funding include, amongst others, wide-ranging projects and instruments for SMEs (InnoBooster). The objective of the Research 2020 programme is to prioritise research funding by making good use of dialogue and consultation procedures between research communities. The areas of emphasis are a society based on a green economy, on health and high quality of life, on high-technology innovation capacity, on efficiency, and on knowhow and social harmony. The targets of the Manufacturing 2025 programme, led by Aalborg University, are, first, to promote awareness of the need for innovative solutions if Denmark is to be able to hold on to industrial jobs. The second objective is to create proposals for new business models for Danish industrial enterprises.

Growth teams have been established in Denmark and tasked with relieving obstacles to business operations and to improve their conditions for success. The determined growth areas are shipping navigation, solutions related to water, biotechnology and the environment, energy and climate, tourism and recreation, creative business and design, the food industry, health and wellbeing solutions, data traffic and communications technologies, and digital growth. SME markets and employment rates will be promoted by the newly-established Market Maturity Fund. This supports development activities for new products and provides services relating to development of business operations models, automation, and digitalisation. Denmark's Ministry of Industry, Business and Financial Affairs, or Ministry of Business and Growth as it's more informally called, in 2014 set up a panel, Production Panel 4.0, composed of business leaders whose task is to draw up proposals for how Danish companies can make the best possible use of digitalisation.

3 THEME-SPECIFIC RESULTS



3 THEME-SPECIFIC RESULTS

3.1 Information society: Finland's high level of education is weakening

Finland's education standards on the wane

The level of Finnish education has been customarily regarded as excellent. Statistics and comparisons show, however, that in comparisons of the proportion of college- and university-educated young adults (25–34 years of age) in the OECD countries in 2015, Finland was only in twentieth place, jointly with Spain, Slovenia, and Estonia. In 2000, Finland ranked third. So, many of the countries that were rated lower at that time have increased their share of people with higher education degrees considerably. While the average growth percentage of the number of people with higher education degrees was approximately 0.8% in 2005–2015, the growth rate was clearly higher in most of the countries. Even Canada, where people with higher education degrees account for approximately one half of the working-age population, increased the share of people with higher education degrees by 1.0 per cent. (Education at a Glance 2016: OECD Indicators).

Basic education and schooling

Basic education and schooling provides the base for subsequent studies and learning, which emphasises its role as the provider of basic preparedness for the knowledge society. In the Technology Barometer, assessing the level of basic education and schooling is based on the results of the Programme for International Students Assessment (PISA) and the student/teacher ratio in primary- and secondary-level education.

Indicator 1.16. Relative ranking of the comparison countries on basic education based on the PISA study and on the student/teacher ratio.

Based on these partial studies, a combined index was produced to describe the comparable countries' ratings regarding basic education and schooling. Although the skills of Finnish children and youth have weakened, they are still highly ranked, coming in at fifth place internationally. Of the reference group of countries only Japan is ahead, in fourth place. It's interesting to note, too, that in the 2015 PISA results Finland was overtaken by Estonia. In 2016, Sweden, the Netherlands and Germany were above the average in addition to Finland and Japan.

PISA is a research programme launched jointly by the OECD member countries to produce information on how young people leaving basic education are capable of searching for, applying and producing information to solve various problems. PISA therefore emphasises the application of skills in various everyday-life contexts. The PISA programme assessments are carried out at 3-year intervals measuring the reading literacy and mathematical and scientific skills of young people (Ministry of Education and Culture, 2016). The main subject areas of the survey vary for each survey round. In the most recent study, conducted in 2015, the main focus area was the natural sciences.

PISA defines literacy as "understanding, evaluating, using and engaging with written texts to participate in society, to achieve one's goals, and to develop one's knowledge and potential". Similarly, the mathematics test emphasises the application of knowledge. For PISA 2012, mathematical literacy was defined as "an individual's capacity to formulate, employ, and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts, and tools to describe, explain, and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens" (PISA Mathematical Literacy Expert Group, 2010). As for the natural sciences, a vital requirement is mastery of the fundamentals of scientific thinking. This is all a question of the civic skills needed in a scientifically and technologically advanced society: as the PISA 2015 study puts it, a solid base of science literacy "is necessary not just for those who are interested in becoming scientists and engineers; all young people need to understand the nature of science and the origin of scientific knowledge so that they can become better citizens and discerning consumers". Scientific literacy rests on the ability to make appropriate use of scientific research, to think critically about it and formulate questions and conclusions in light of the best available evidence about the natural world, and to develop an understanding and appreciation of the changes to the natural world caused by human action so as to be better equipped to promote and contribute to decision-making on these matters. This also emphasises a way of putting information and knowledge into proportion in

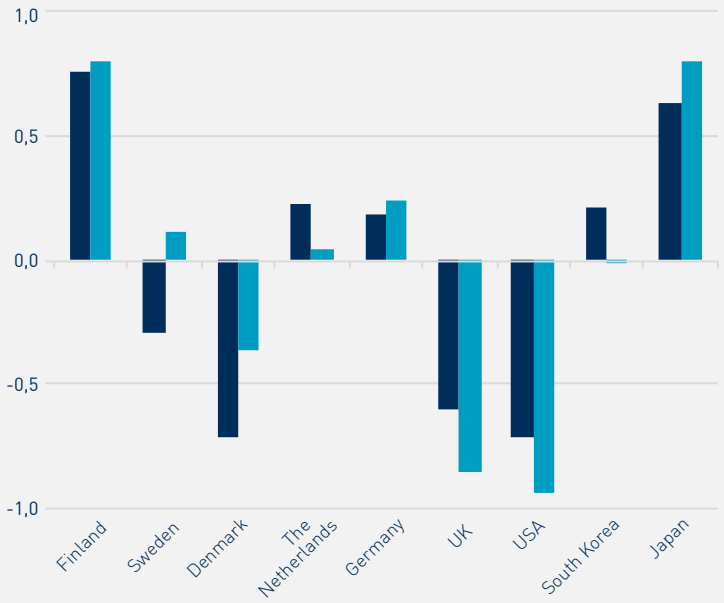
which a distinction is made between opinions and scientifically tested and grounded claims.

As a whole, the PISA comparison shows more than in previous years that the skills levels of Finnish youth in the natural sciences and mathematics are weakening. In spite of the downward trend, young people's reading literacy is still at a high level. In the most recent PISA survey from 2015, Finland was the third best OECD country and sixth among all of the 73 included after Singapore, Hong Kong, and Canada. Compared to 2003, however, the average of reading literacy has decreased by 17 points in Finland, a statistically significant number.

Correspondingly, the average of mathematical literacy has decreased by 33 points compared to the 2003 assessment, which is a statistically significant number. Apart from in Finland, among the comparison group countries the average has dropped most clearly in the Netherlands (-26 points), South Korea (-18 points) and Sweden (-15 points). In the group as a whole, in level of mathematics skill there has been a trend towards growth only in Germany, and a very slight one at that (+3 points). Overall, however, Finland's average in the OECD country group puts it in seventh place, jointly with Denmark. Ahead of them in the ranking are Japan, South Korea, Switzerland, Estonia, Canada, and the Netherlands. Finland ranked thirteenth of all 73 of the included countries and regions.

Figure 1. Young people's mathematical skills in the PISA survey (OECD, PISA Results 2003–2015).

A corresponding trend is taking place in Finland in assessing scientific skills. The trend is clearly a descending one, even though Finland continues to be among the top OECD countries. It is notable that the average level of scientific skills has decreased by 32 points since 2006, although



INDICATOR 1.16.

Relative ranking of the comparison countries on basic eduction based on the PISA study and on the student/teacher ratio.

TECHBaro2014
TECHBaro2016

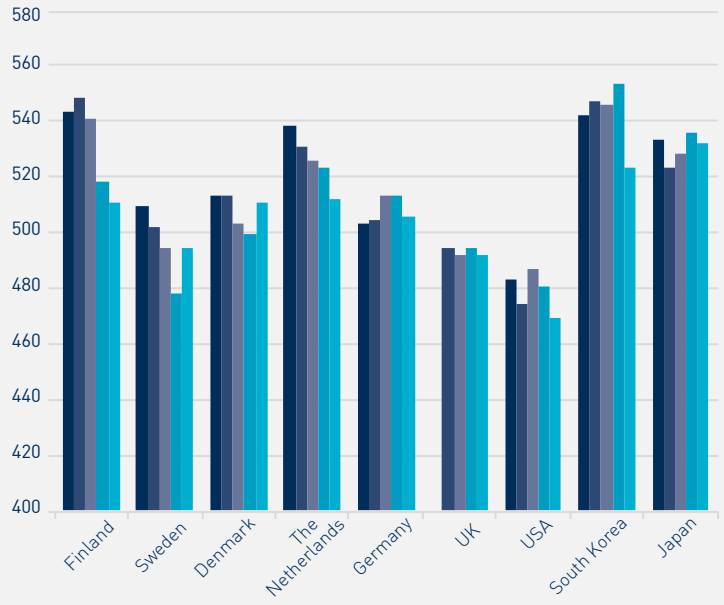


FIGURE 1.

Young people's mathematics skill in the PISA study (OECD, PISA Results 2003–2015).

2003
2006
2009
2012
2015

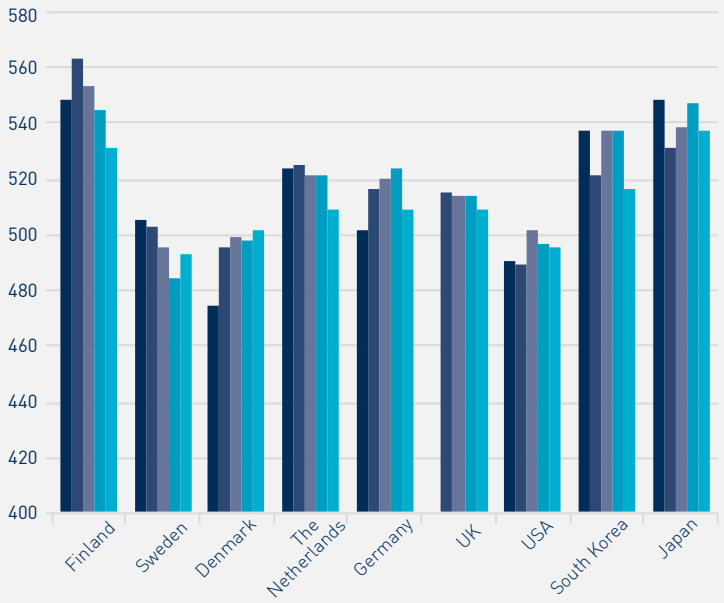


FIGURE 2.

Young people's skill in the natural sciences as measured by the PISA study (OECD, PISA Results 2003–2015).

the OECD average has increased by three points during the same period. An increase in the number of those with poor skills is the most significant factor contributing to the decrease in Finland's score. The motivation to study the natural sciences, a respect and appreciation for them and a proven trust in the value of scientific expertise were markedly below average, and at best average among the OECD countries. The problem with this, of course, is that motivation and attitude are intimately linked to success in the natural sciences. In spite of the descending trend, Finland's rating in scientific skills was still excellent in PISA 2015. In the OECD country group Finland was third, behind Japan and Estonia. Including all of the 73 participating countries and regions, Finland had the fifth-highest score.

The above can also be clearly seen in the Technology Barometer comparison. Finland's competence, although still high, is demonstrably receding. Of the countries compared, there has been a clear upward trend in skills in Denmark as well.

Figure 2. Young people's scientific skills (OECD, PISA Results 2003–2015).

Judged by student/teacher ratio also, Finland is middle-of-the-road among the reference countries. In secondary-level education, this country's position has improved in this regard, to give joint second place with Sweden. However, there was not enough data on secondary-level student/teacher ratios to include it in the comparison.

Young people's interest in society, science and technology

For many young people, science and technology is just one object of interest among several other themes of societal interest, in addition to arts, sports and entertainment.

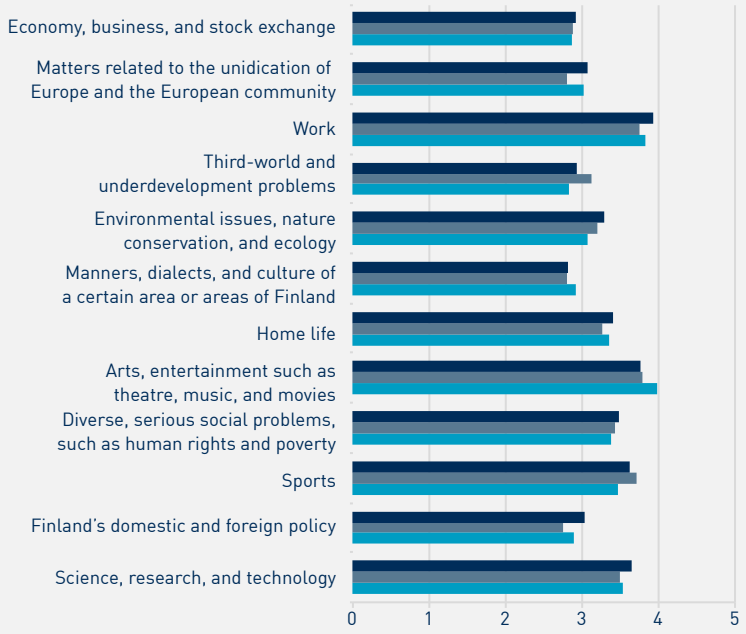
Youth considered work to be the most interesting thing, and interest in it grew statistically by a significant amount from 2014. The arts and entertainment were rated as more interesting than science. After science came sport.

Survey graph 1.5. Young People's interest in various social matters. (Question presented: The following is a list of matters that may interest people. How interested are you in them? Interest may consist of following the news, TV and radio programmes and articles on a particular theme, for example. 5 = Very interested, 4 = Fairly interested, 3 = Difficult to say, 2 = Fairly little interest, 1 = No interest.

The sources from which young people draw their views and knowledge related to science and technology are also of interest. Similarly to previous years, Young People estimated the internet, their own work and/or education and television/radio to be the most important sources of information in the 2016 survey.

South Korea and Denmark make growing investments in education

The Technology Barometer now measures citizens' general education and skill using three indicators. The combined index consists of the proportion of gross national product spent on education, the proportion of the population accounted for by those with a college degree, and degree of participation in lifelong learning. The combined indicator produced with these comparisons does not indicate any marked change between the countries' relative differences, apart from showing that South Korea has consolidated its lead. Denmark is clearly still ahead of Finland and Sweden in all-round education and skill, judging by the indicators measuring these. In the indicators applied, Japan's and Germany's results were the worst.



SURVEY GRAPH 1.5

Young People's interest towards various societal issues.

(Question presented: The following is a list of issues which may interest people. How interested are you personally in these issues? Interest may consist of following the news, TV and radio programmes and articles on a particular theme, for example.

5 = Very interested,
4 = Fairly interested,
3 = Difficult to say,
2 = Fairly little interest,
1 = Very little interest.

- Young People2016
- Young People2014
- Young People2011

General education and competence of the populace is also measured indirectly by the share of educational expenditure in the nation's GDP. As a whole, educational expenditure consists of public and private investment in education and training made by the state, enterprises, students and their families. However, the most part of educational expenditure is covered by public funding. In 2013, in the OECD countries public funding accounted for 87% of total educational expenditure on average. Nevertheless, the share of private funding varies considerably from one system to the next.

Indicator 1.17. Relative ranking of the comparison countries on all-round education and competence measured by the proportion of GDP spent on education, on the proportion of the population with a college degree, and on indicators of lifelong learning.

Of the Technology Barometer comparison countries, in 2013 the proportion of private funding sources among all funding for education was in Finland around 2%, compared to over 30% in the United States and South Korea. In spite of the plentiful private funding in South Korea, the proportion of GDP spent on education is also high: the country is ranked second among the comparison countries on this score, after Denmark and ahead of Sweden and then Finland.

The demographic group with higher education qualifications is a commonly used indicator of the supply and availability of a qualified workforce. In addition to this, it is often thought to more widely reflect the nation's competitiveness in a knowledge-intensive economy and innovation activities. Among other things, the countries' mutual differences are influenced by the education system structure, the demand for qualified employees, and the resources available to education and training. Among the population with higher education degrees, the average figure in the OECD countries in 2011 was 35 per cent. The highest proportional share is found in Canada where 55 per cent of the people aged 25–64 had a higher education degree. Other countries with high proportional percentages included Japan (50 per cent), Israel (49) the US (45) and South Korea (45). In Finland, the share of people aged 25–64 was 43 per cent. (OECD Education at a Glance 2016)

The share of people with higher education degrees is rising steadily in the reference group countries studies in the Technology Barometer. Instead of being a country-specific phenomenon, this obviously reflects a global endeavour to expand the coverage of higher education. The top countries of the comparison are Japan and South Korea, the latter of which has quickly caught up with and overtaken the formerly-superior United States. The position of the US is explained by several factors, including the fact that third-level education there typically begins at a later age than in many other countries. However, the general trend is towards diminishing differences in the share of higher education between the countries being compared. In Finland, the share of people with a higher education degree has continued to increase clearly, and is roughly on a par with South Korea and the UK.

A third partial indicator of general education and skill is participation in lifelong learning. Lifelong learning has become an essential element of updating people's working life skills and maintaining competitiveness. At the same time, lifelong learning provides a means of reducing unemployment and preventing social exclusion. In the OECD countries, on average 50 per cent of adults participate in education during a 12-month period, either within the education system or in externally provided education and training. Spearheading the ranking are New Zealand and the Nordic countries, with around 65 per cent in each of them. The Technology Barometer uses the Eurostat's questionnaire-based data as an indicator. The questions on participation in education concern any possible participation in the four weeks preceding the survey. This explains why the figures are lower than those obtained from the OECD statistics. The top four countries are the same four that lead in public funding of education, with South Korea now leading the comparison.

The Nordic countries in the lead in comparisons of scientific-technical competence

The Technology Barometer measures techno-scientific skill with seven indicators. Finland is still the leader among the reference group of countries, even though our relative standing has weakened. Among other factors, the situation is influenced by the decreased share of Finnish R&D personnel and those employed by high and medium-high technology industries. At the tail end, Japan, which has also lost its position compared to the study of two years ago.

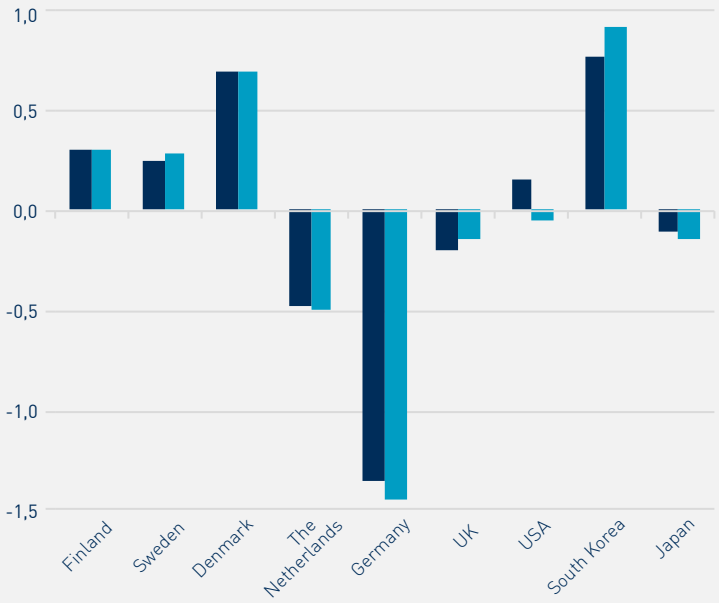
Indicator 1.18. Relative ranking of the comparison countries on techno-scientific competence measured as a proportion of the labour force with a college degree, the proportion that has completed a tertiary-level degree, the proportion of the labour force accounted for by employees in advanced-technology industry, services, and R&D personnel, and the proportion of researchers that are female.

Of the indicators used, the first measures the demographic share of people with higher education qualifications. This indicator is not restricted to the fields of science and technology, due to the fact that the adoption of innovations increasingly requires a wide variety of skills. Technologies, for example, are connected to a variety of services and what companies need to operate is multidisciplinary competence ranging from economics and law to behavioural sciences. The next two indicators are

used to measure the number of graduates in new fields of science and technology, as well as the share of people with higher education qualifications in technology and doctoral degrees in the demographic group of people aged 20–29 and 25–34, respectively. The following indicators describe the share of R&D personnel in the labour force, plus the share of women among researchers. The final two indicators show the proportional share of citizens employed by high and medium-high technology industries, and by related competence-intensive services.

The proportion of the total workforce consisting of those who have received a university-level education has grown in recent years in every one of the comparison countries, except for Germany. The result of the comparison is largely similar to the proportion of the overall population that has received a university-level education: Finland has the joint lead with the United Kingdom (data on Japan and Korea were lacking). One very noteworthy observation is the proportion in the United States. One explanation for this could be that the US has many highly-educated women who are not part of the workforce.

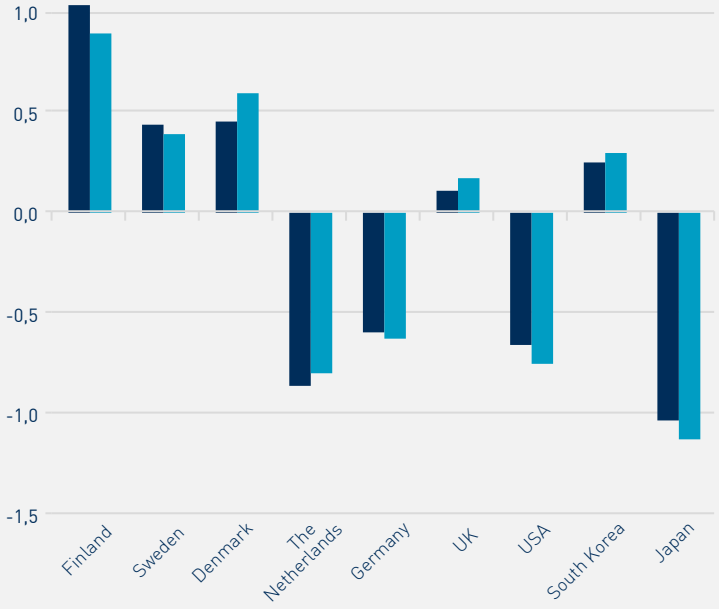
The share of technological-scientific degrees more accurately describes the labour force available to companies in these sectors, as well as the nation's potential for innovations in these domains. Techno-scientific degrees are those that include all higher education examinations in biology, physics, mathematics and statistics, information technology, engineering and technology, material production and processing, architecture and construction. Finland has traditionally had a high number of first-term students in these fields. In 2014, Finland had the third-highest share of first-term students in engineering in the OECD countries, after Mexico and South Korea. (OECD Education at a Glance 2016) Finland's strength is also indicated by the Technology Barometer comparison showing the proportion of degrees in science and technology in the age group



INDICATOR 1.17.

Relative ranking of the comparison countries on all-round education and competence measured by the proportion of GDP spent on education, on the proportion of the population with a college degree, and on indicators of life-long learning.

- TECHBaro2014
- TECHBaro2016



INDICATOR 1.18.

Relative ranking of the comparison countries on scientific-technological competence measured as a proportion of the labour force with a college degree, the proportion that has completed a tertiary-level degree, the proportion of the labour force accounted for by employees in advanced-technology industry, services, and R&D personnel, and the proportion of researchers that are female.

- TECHBaro 2014
- TECHBaro 2016

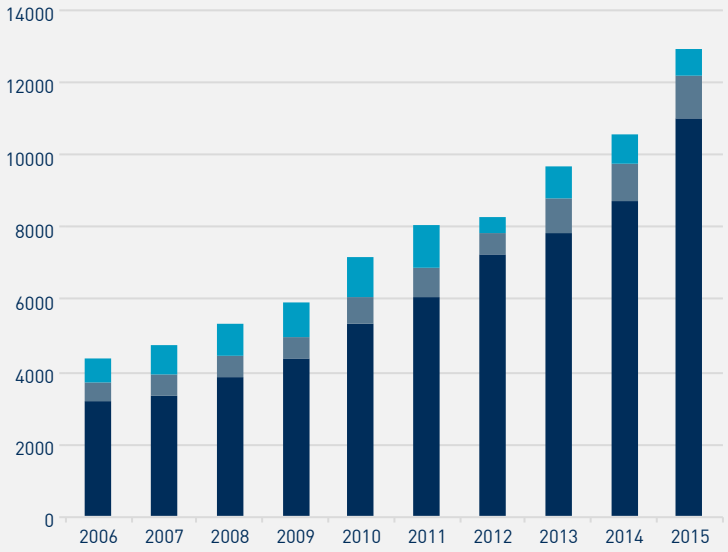


FIGURE 3.

Added value created by Denmark's three largest biotechnology and pharmaceuticals companies, Novo Nordisk, Novozymes, and Lundbeck (in millions of euros), calculation based on statistics obtained from the Orbis private enterprise database.

20–29. Finland is second in the comparison, behind Korea. However, it is interesting to note that in the 2008–2012 period the share of techno-scientific degrees has increased in all of the reference countries, besides Japan. This is also the case in Sweden, where the share of degrees in engineering and sciences was falling in 2005–2009.

A similar trend is seen in the number of doctoral degrees in techno-scientific fields by the 25–34 age group. In Sweden and Finland, which have the lead, the proportion has been decreasing. Denmark, the United Kingdom and South Korea have now caught up with Finland. The development has been especially bracing in Denmark and the Netherlands. Denmark's development may be explained by the country's impressive growth in its pharmaceutical and biotechnology sectors; the major degree of added value created in these fields is shown in Figure 3.

Figure 3. Added value created by Denmark's three largest biotechnology and pharmaceuticals companies, Novo Nordisk, Novozymes, and Lundbeck (in millions of euros), calculation based on statistics obtained from the Orbis private enterprise database.

A closer examination of the share of labour force employed in research and product development, which requires a high level of competence and constitutes one of the cornerstones of the knowledge-intensive economy, indicates that Finland has retained the highest rating among the countries being compared, remaining close to two per cent. However, the share is in decline. The trend has possibly been affected by the economic situation, with companies cutting their R&D expenditure after 2008 for the first time after the turn of the millennium, on the one hand, and decrease in public R&D funding in real terms since 2011, on the other hand. On the other hand, the proportion of people working in Denmark's research and development activity has grown by one-third within a decade, bringing it up to Finland's high level.

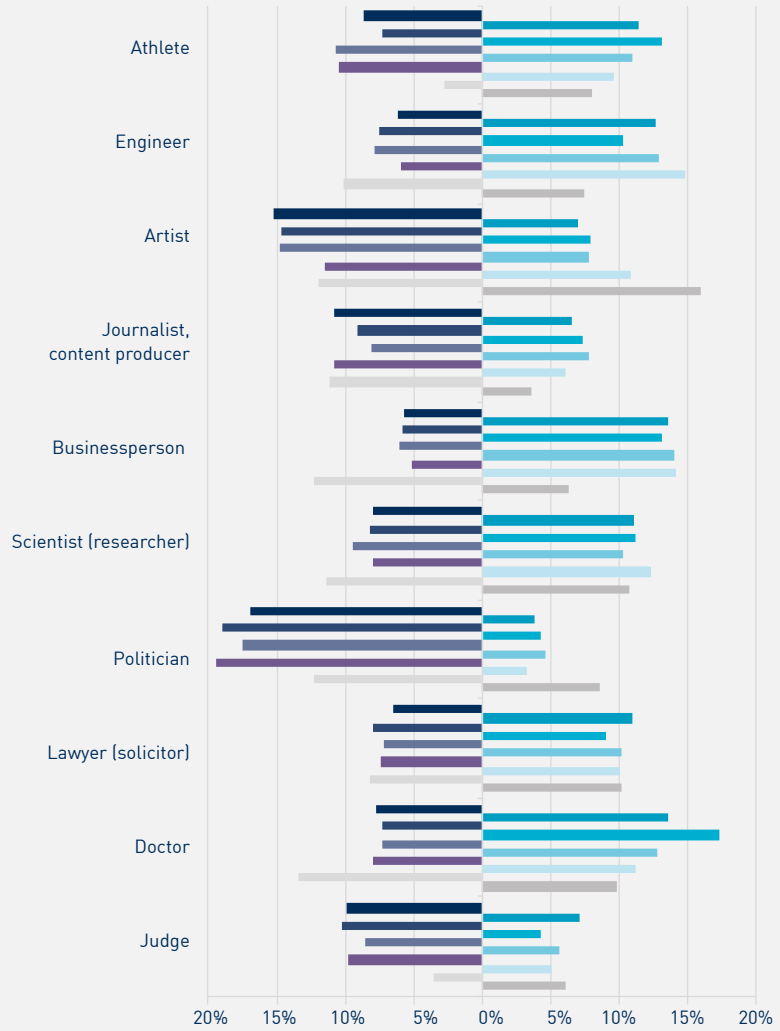
The share of women among researchers seems to be growing in most of the countries being compared, or at least has not declined. The clearest exceptions are Sweden and the Netherlands, with the former in particular showing a noticeable drop since 2011 in the proportion of female researchers. Sweden has indeed lost ground to Denmark, which is now in third place on this score behind the United Kingdom.

The percentage of the total labour force employed in high- and medium-high technology industries reflects the major proportion of overall economic activity that is accounted for by R&D-intensive technological enterprises. The central products in this category include chemical products, machines and equipment, computers and business machines, electrical appliances, data communication equipment, precision instruments, motor vehicles, aircraft and other vehicles. The proportion is heading downward in all of the Nordic countries, but remains high. When the analysis is extended to the proportion of the workforce in high-technology industry and skill-intensive services, no similar drop is noticeable. The table shows that Finland has the highest share among the countries being compared in this respect (however, data was not available for all of the countries). The level remained reasonably stable throughout the whole of the past decade.

Youth are most interested in becoming doctors, entrepreneurs, and engineers

Graph 1.2 compares the interest expressed by upper secondary (high school) students in various professions. In this question, upper secondary school students were asked to say which professional sectors they find most agreeable, and which interest them least. The results for 2016 were compared to those from 2014, 2011, 2009 and 2007.

Survey graph 1.2. Interest in different professional groups. The respondent group is young people. The percentages indicate the proportion of responses of the total responses to the survey. (Question presented: Several professions and



SURVEY GRAPH 1.2

Interest in different professional groups. The respondent group is Young People. The percentage shares describe the proportion of responses of the total responses to the survey.

(Question presented: Several professions and work tasks are listed below. Which of these fields are ones in which you would prefer to work? Choose two to four fields. And which fields interest you the least?).

2016		RANKING 2014	RANKING 2011
1	Doctor	1	2
2	Businessperson	2	1
3	Engineer	5	3
4	Athlete	3	6
5	Scientist (researcher)	4	5
6	Lawyer (solicitor)	6	4
7	Judge	9	8
8	Artist	7	9
9	Journalist, content producer	8	7
10	Politician	10	10

work tasks are listed below. Which of these fields would you prefer to work in? Choose two to four fields. And which fields interest you least?)

The clearest trend-like changes during the survey rounds in 2009–2014 were an increase in interest in becoming an athlete and doctor, and lessened interest in becoming an engineer or artist. In the most recent measurements, this trend for the first three of the aforementioned professions has reversed, and the three most important professions are now doctor, entrepreneur, and engineer.

Table 1. Regard for professions among upper secondary school students. Appreciation is calculated by deducting the number of uninterested choices from the preferred ones and by sorting the results.

In 2016, the three key factors underlying the choices were, as in previous years, the field's intrinsic interest, pleasantness, and salary. From the results obtained, it seems young people mostly make career-related choices based more on the content of work and salary rather than working conditions. Job security is again in fifth place.

In addition, young people were asked, as in previous years, about their interest in working in technology or as an engineer or artist. No significant changes have taken place in young people's assessments. The differences detected between enquiries made in different years are relatively minor ones and are probably due to random variations. Young people agreed most with the following statements: graduate engineers and architects have a high income level, work in the field of technology offers good opportunities for learning, and the skill of graduate engineers and architects is world-class in Finland.

3.2 Knowledge society: Investment in R&D is becoming worryingly stagnant

Company and public-sector funding investments in research and development is still weakening...

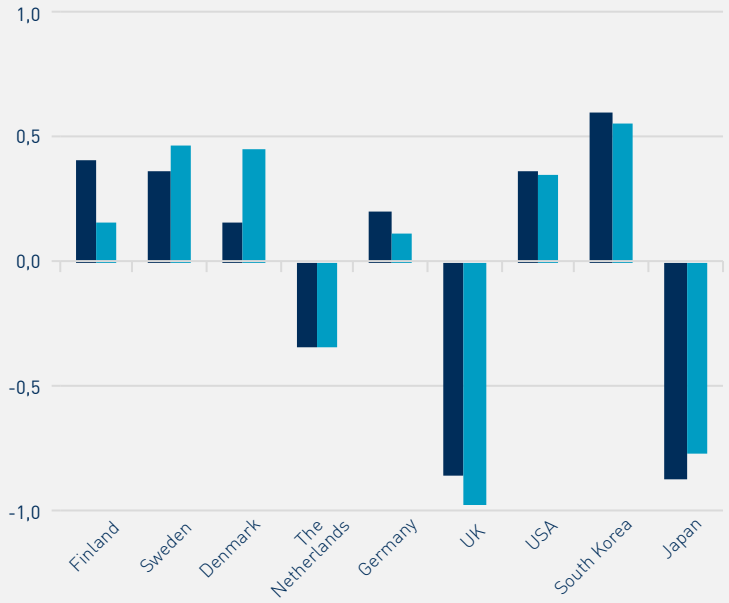
Sufficient R&D investments are a necessary, even if not in themselves sufficient, condition for successful innovation activity.

Relative to the 2014 Technology Barometer, this time round Finland's standing compared to the reference group of countries had weakened, although it is still somewhat above average (Indicator 2.26). Finland lost ground particularly to Sweden, Denmark, and the US. Also Germany, which in the 2014 Barometer was behind Finland in R&D investments, is now almost neck-and-neck. Compared to the previous measurement, Denmark has most improved its position in R&D investments.

Indicator 2.26. Relative ranking of the comparison countries on investments in research and product development measured by public and private R&D expenditure as a proportion of GDP, and by R&D expenditure as a proportion of public financing.

Globally judged, R&D investments have in the past few years (2011–2014) been on the increase. Growth has however been relatively slow, for reasons including tighter R&D investment in high-income countries, such as the United States, Japan, and certain European countries. Another reason is the slowdown of ascending economies, above all China, in R&D investment (Global Innovation Index 2016).

Examined over a slightly longer period, the trajectory of investment in research and development has fluctuated, and in the financial crisis of 2007–2009 it was considered something of a dividing issue. During the crisis and imme-



INDICATOR 2.26.

Relative ranking of the comparison countries on investments in research and product development measured by public and private R&D expenditure as a proportion of GDP, and by R&D expenditure as a proportion of public financing.

TECHBaro2014
TECHBaro2016

diately after it, investment in R&D generally fell. After this the development in different countries has been so divergent as to have led to the creation of three distinct classes. This three-way distinction has been explored recently by the Global Innovation Index (2016, 5). Belonging to the first category are those countries in which R&D investments did not drop during the financial crisis, and in which they have grown strongly since then. These countries include China, South Korea, and Denmark; and the latter, as we have seen in the present report, have continued to vigorously strengthen its investments. In the second category are the countries in which R&D investments fell during the crisis, but have since then risen. Such countries are, for instance, the Netherlands, Estonia, Germany, Norway, and the United Kingdom. The final category contains the countries where R&D investment dropped during the crisis and has remained below pre-crisis levels. Finland is in this category, as are, among others, Sweden, Canada, Spain, Greece, Portugal, and Romania.

According to data analysed by Statistics Finland, this country's R&D expenditure in 2015 was 6.1 billion euros, down 440 million on the previous year. Investment by companies in product development decreased by 360 million euros, or about 8 per cent. In the electronics and electricity industries the drop was 440 million euros. Research spending in the higher education sector R&D stayed more or less the same, but in sector research departments and elsewhere in the public sector the relative decline in R&D investments was even greater than in the private sector, at over 11 per cent (70 million euros). The proportion of gross national product accounted for by R&D expenditure in 2015 was 2.9 per cent. The proportion of gross national product on R&D expenditure in Finland has waned continuously since 2009, when it was 3.8 per cent. The business sector's share of research and product-development spending dropped in the 2008–2015 period from 74 to 67 per cent. In 2016, research and development spending fell by an estimated 100 million euros, leaving their proportion of the GDP at 2.8 per cent.

Figure 4. Research and development investment by sector, 2009–2016*. http://www.stat.fi/til/tkke/2015/tkke_2015_2016-10-27_tie_001_fi.html).

Company investment in R&D in Finland decreased clearly in the 2011–2013 period (Indicator 2.1). Of the comparison countries, over the same period R&D investment dropped in Denmark and the United Kingdom also, but considerably less than in Finland. From Finland's point of view, it is also notable that this is just a continuation of the downturn that began in 2009. In the other reference countries, investments of companies in research and development were climbing, or at least not falling. It should also be noted that if the 2014 figures are taken into consideration, the share of GDP accounted for by R&D investment in Finland dropped from 2.26 per cent in 2013 to 2.15 the following year.

Indicator 2.1. Companies R&D expenditure, percentage of GDP (Eurostat).

Judged in absolute terms, companies' R&D investments have been falling in Finland since 2011, adding up to a total decrease of around 650 million euros. And according to the most recent data this downhill slide is accelerating, since the drop from 2013–2014 was nearly 200 million euros. Statistics Finland estimated in 2015 that the drop in R&D expenditure for that year would be around 20 million euros (Statistics Finland 2015a). At its highest, in 2009, company R&D investment in Finland was 5.102 billion euros, from which the fall to the 2014 level was almost 700 million. The drop last year partly shows the effect of Nokia's fortunes, since taken by operational area the major drops have been in software (57 million), the electronics industry (39 million). And in the operational sector that groups together other machinery and equipment, the drop was about 62 million euros (Statistics Finland 2015b). Nokia's investments in research and development have fallen dramatically in recent years, and in 2013–2014 they plummeted a further 126 million euros. However, Nokia remains by far Finland's biggest investor in R&D, because in 2014 its investments in R&D activity (2.493 billion euros) were over ten times those of the next most significant investor, ABB (203 million), and even more than the next 99 companies put together (2.404 billion euros). [2]

It is significant, too, that despite the general slump in R&D investments, some investors made large increases in this area in 2013. These companies include indicators OP Group (+38%), Stora Enso (+30%), and Tieto (+25%).

... and confidence in the profitability of public investment in R&D is poorer than before

Public investment in research and development also fell in Finland from 2011 to 2013 as a proportion of GDP (Indicator 2.2). In most of the reference countries public funding to R&D has been growing, except for (alongside Finland) Germany and the United Kingdom. But the drop in Finland has been sharper than in either of those two. Public R&D expenditure grew in Finland in absolute terms from 2013 to 2014 by about 20 million euros, but then took a clear downturn in 2015. In that year, the spending fell by almost 100 million euros, to 2.0035 billion (Statistics Finland 2015a).

Indicator 2.2. Public R&D expenditure, percentage of GDP (Eurostat).

[2] The figures on R&D investments by private companies are based on data for several years collected in the journal Tekniikka ja Talous (see for example Lukkari 2015).

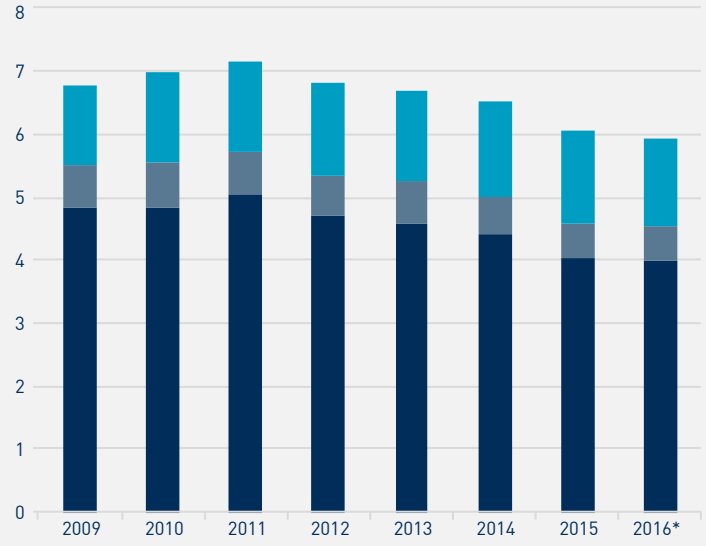
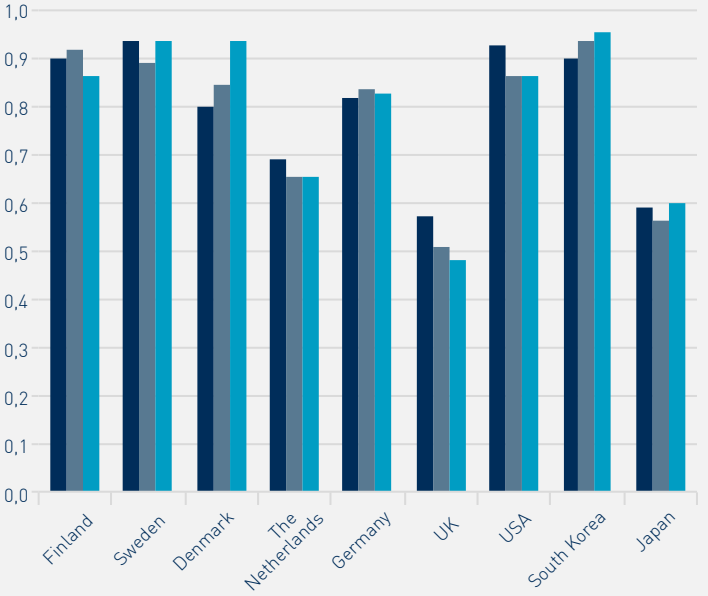


FIGURE 4.

Expenditure research and development activities by sector, 2009–2016*.

http://www.stat.fi/til/tkke/2015/tkke_2015_2016-10-27_tie_001_fi.html).

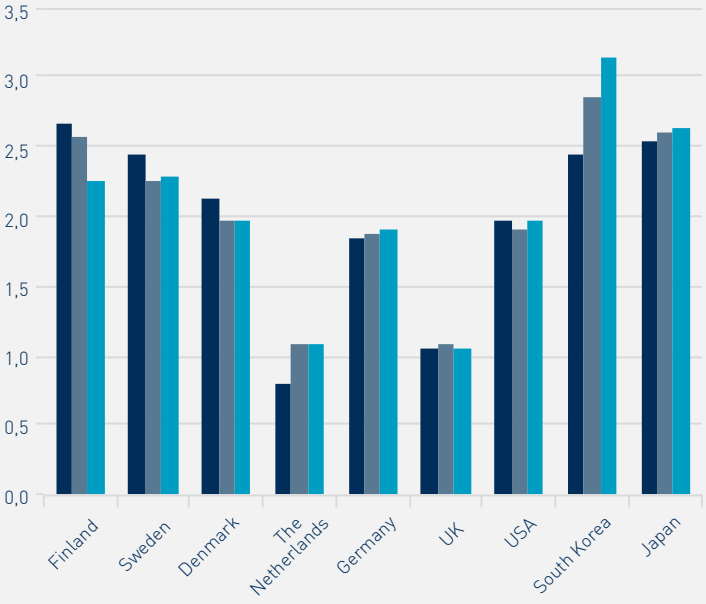
- Korkeakoulusektori
- Julkinen sektori
- Yritykset



INDICATOR 2.2.

Total intramural R&D expenditure by government (GERD), % of gross domestic product (GDP). (Eurostat).

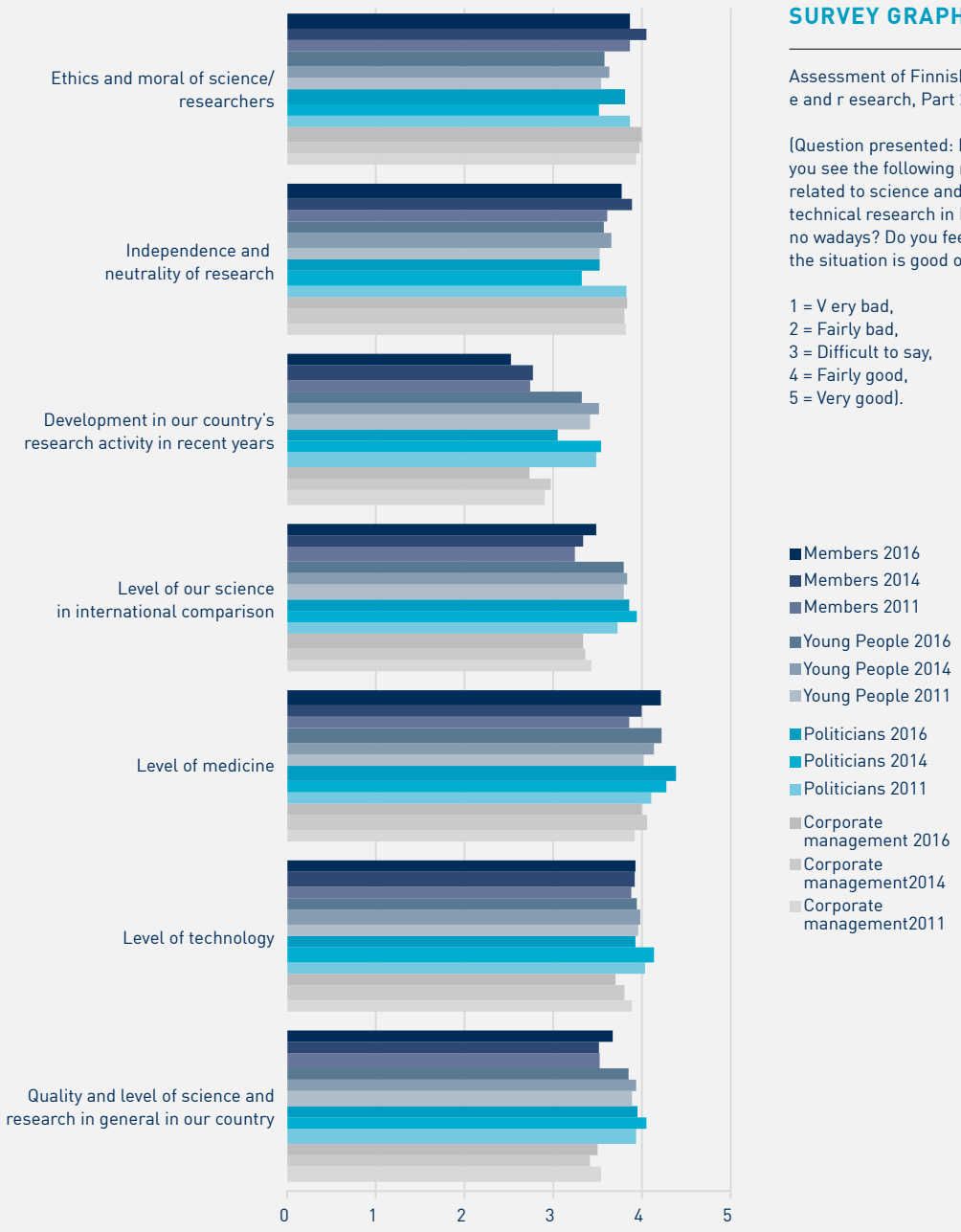
- 2009
- 2011
- 2013



INDICATOR 2.1.

Total intramural R&D expenditure (BERD), business enterprise sector (Eurostat).

- 2009
- 2011
- 2013



SURVEY GRAPH 2.2

Assessment of Finnish scienc e and r esearch, Part 2.

(Question presented: How do you see the following matters related to science and to technical research in Finland no wadays? Do you feel that the situation is good or bad?

1 = V ery bad,
2 = Fairly bad,
3 = Difficult to say,
4 = Fairly good,
5 = Very good).

Of course from Finland's perspective it is notable that the 2015 figures don't say much about whatever effects the current, Juha Sipilä-led government, which took office in the middle of that year, may be having through the cuts to R&D investments it imposed. It was decided in the Sipilä government programme to reduce R&D financing by 263 million euros over the course of the electoral period (2015–2019), which adds up to a cut of around 13 per cent in State funding for research and development (Office of the Council of State 2015).

The most important of these cuts are:

- Enterprise Finland: -95 million
- The Strategic Centres for Science, Technology and Innovation (SHOK) programme and the Innovative Cities (INKA) programme, together -43 million
- Universities -75 million, in addition targeted cuts to the budget of the University of Helsinki and the University of Eastern Finland -35 million
- The Finnish Academy -10 million
- Research institutes -22 million

The cuts to public R&D financing are partly an indication that the confidence of political decision-makers in the profitability of supporting R&D activity has waned. The 2017 Technology Barometer survey lends support to this view: there is less faith than before among politicians that investing in research will bring large societal benefits (Graph 2.2).

Survey graph 2.2. Assessment of Finnish science and research, Part 2. (Question presented: How do you see the following matters related to science and to technical research in Finland nowadays? Do you feel that the situation is good or bad? 1 = Very bad, 2 = Fairly bad, 3 = Difficult to say, 4 = Fairly good, 5 = Very good).

... but company heads believe R&D investments will continue

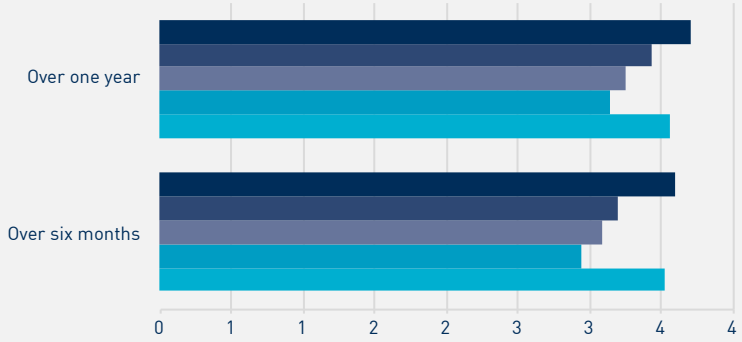
The faith of business leaders in increasing the rate of R&D investments is stronger in the 2017 Technology Barometer than in 2014 (Graph 2.13).

Survey graph 2.13. Product development investment trends. (Question presented: How do you see the R&D investment of your enterprise developing over the next 6 months? And over the next 12 months? 1 = It will decrease considerably, 2 = It will decrease, 3 = Difficult to say, 4 = It will increase, 5 = It will increase considerably).

This view has been gaining ground since the measurements of 2009, but is now doing so a bit faster than before, especially when examined over the short term. On the other hand, there's still plenty of uncertainty, because the responses to the aforementioned questions don't score above 4.

Views on the effects of information technology on working life

Graph 2.10 depicts the assessments by TEK members of the impact of information technology on their ways of working. The figure presents the responses from 2016, 2014, 2009 and 2011. The most remarkable change from 2014 is in the responses to the question about increasing responsibility at work. TEK members also felt an increased burden from work (through the so-called information glut), but they also saw some ways in which the burden has eased. The members agreed most strongly with the statements "Work has become more burdensome (information overload)" and "You now do more tasks in the day than you did before".



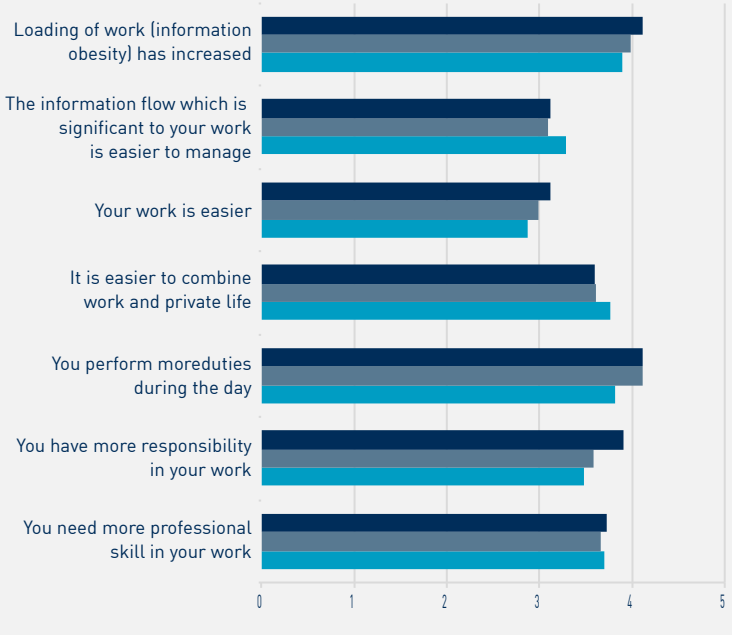
SURVEY GRAPH 2.13

Product development investment trends.

(Question presented: How do you see the R&D investment of your enterprise developing over the next 6 months? And over the next 12 months?

1 = It will decrease considerably,
2 = It will decrease,
3 = Difficult to say,
4 = It will increase,
5 = It will increase considerably).

- Corporate management 2016
- Corporate management 2014
- Corporate management 2011
- Corporate management 2009
- Corporate management 2007



SURVEY GRAPH 2.10

TEK Members' assessments regarding the impact of information technology on their work methods.

(Question presented: Considering the use of ICT, such as computers, the Internet or e-mail, how has it changed your work methods? Do you agree or disagree with the following statements?

5 = Fully agree,
4 = Somewhat agree,
3 = Difficult to say,
2 = Somewhat disagree,
1 = Fully disagree).

Survey graph 2.10. TEK Members' assessments of the impact of information technology on their work methods. (Question presented: Considering the use of ICT, such as computers, the Internet or e-mail, how has it changed your work methods? Do you agree or disagree with the following statements? 5 = Fully agree, 4 = Somewhat agree, 3 = Difficult to say, 2 = Somewhat disagree, 1 = Fully disagree).

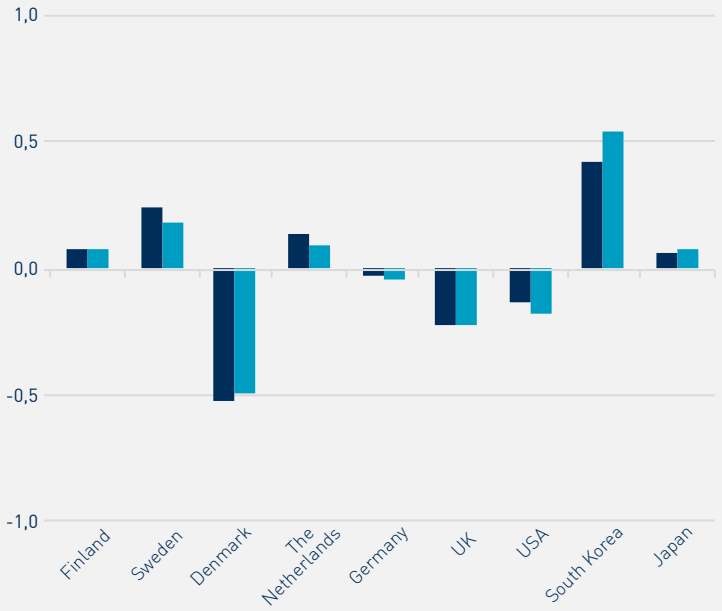
3.3 Knowledge-value society: Finland is now more attractive for investments

South Korea takes the lead on information comprehension and management

The Technology Barometer approaches the understanding of knowledge and knowledge management from two different points of view: R&D achievements, and cutting-edge technology.

Indicator 3.24. The countries' proportional ranking in the understanding of knowledge and knowledge management measured with the share of patenting and scientific articles, productivity of work and the share of high technology production and exports and high and medium-high technology fields and competence-intensive service fields added value of GDP.

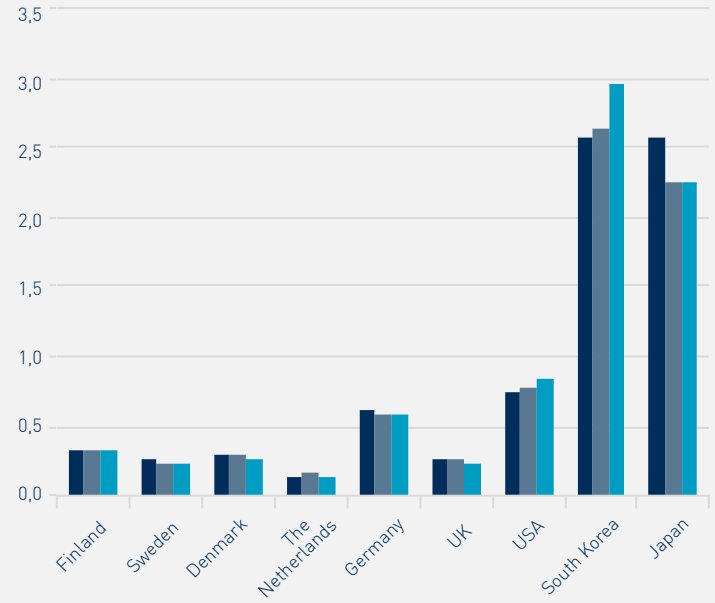
South Korea ranks at the top of the Understanding of knowledge and knowledge management combined index. This is an improvement on the country's performance in the 2014 study. Second place is held by Sweden, and third by the Netherlands. Next come Germans, Denmark and Finland, in that order. Finland, the Netherlands and the United States have slightly lost their proportional rankings compared to the other countries being compared, while Sweden, the UK and Japan have slightly increased their proportional ranking. South Korea's dominance is evident in, amongst other things, its high proportion of patent applications in line with the international Patent Cooperation Treaty (PCT) procedure (Indicator 3.1).



INDICATOR 3.24.

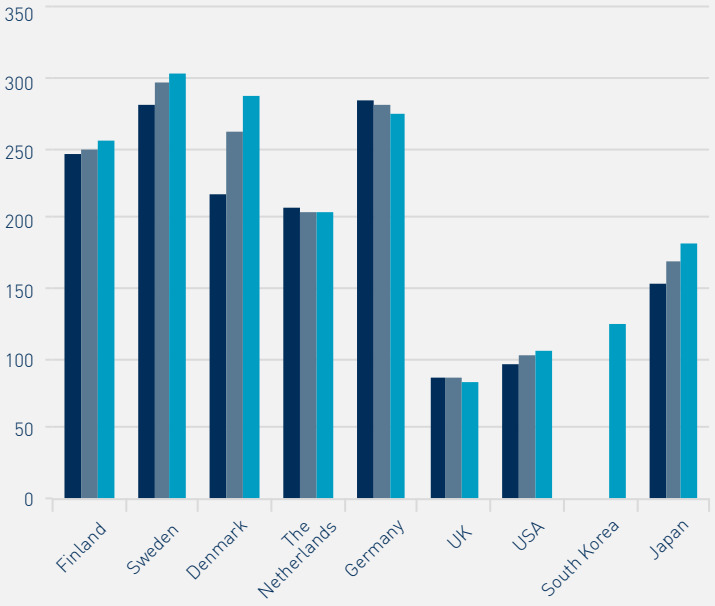
Relative ranking of the comparison countries on comprehension and management of information measured by the proportion of GDP that is accounted for by expenditure on patents and scientific articles, work productivity, manufacturing and export of advanced technology, information and telecommunication technology (ICT) services, and high- and medium-high-technology fields.

TECHBaro2014
TECHBaro2016



INDICATOR 3.1.

Patent applications filed through the PCT procedure. (WIPO).



INDICATOR 3.2.

Patent applications to the European Patent Office. (Eurostat).

Denmark's technology science indicators have developed positively

The Technology Barometer approaches the understanding of knowledge and knowledge management from two different points of view: R&D achievements, and cutting-edge technology. These consist of the number of patent applications filed with the European Patent Office (EPO), the number of high technology patents per one million inhabitants granted by the United States Patent and Trademark Office (USPTO), and the number of scientific articles published per thousand inhabitants.

Indicator 3.1. Patent applications submitted to PCT per million inhabitants. Patent applications filed through the PCT3 procedure.

Patents granted in European countries by the European Patents Office (EPO) have an important role (indicator 3.2). Sweden and Germany have been the most prolific applicants for EPO patents in recent years, but the growth in Denmark's rate of applications since 2009 has been clearly ahead of the rest of the reference countries.

Indicator 3.2. Patent applications submitted to EPO per one million inhabitants.

Taking the lead in 2013 in number of patents granted by the United States Patent and Trademark Office (USPTO) (Indicator 3.3) are the United States and Japan in joint first place, followed by South Korea. Then comes Sweden, with Germany taking third place. In all the reference groups of countries the relative amount of patents granted in the 2010–2013 period has grown.

[3] Patent Cooperation Treaty.

Indicator 3.3. Patents granted by USPTO per million inhabitants (USPTO).

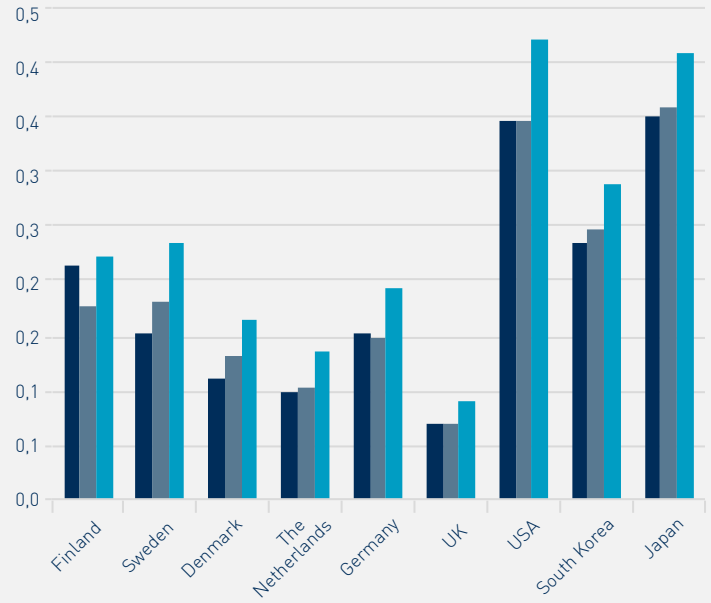
According to Elsevier SCOPUS, the world's largest abstract and citation database of peer-reviewed literature, in 2015 Denmark published more articles per thousand residents (Indicator 3.4) than any other country in the reference group. And the actual number of articles from Denmark also grew fastest.

Indicator 3.4. Number of scientific articles per one thousand inhabitants (Scopus Database, SCImago Journal & Country Rank).

South Korea is impressive on high technology, but not on service exports

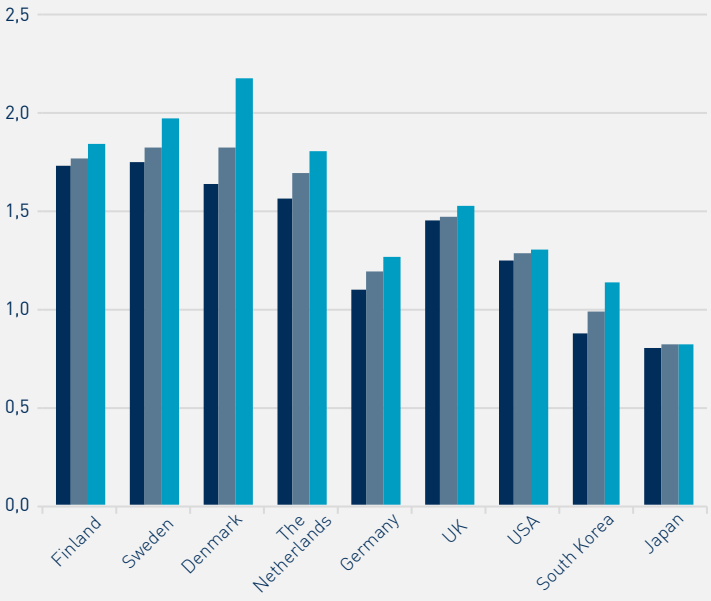
The second Technology Barometer indicator, information comprehension and management, is assessed by examining the efforts countries make in expertise-intensive services and high-technology production and exports.4 In a knowledge-based society, the understanding of knowledge and its management, should be manifested as increasing productivity of labour, and as an increasingly high proportion of GDP accounted for by expertise-intensive services and top-level technology production. The latter effect was clearly evident in the early 2000s. But particularly with the increasing transfer of production of cutting-edge technology to countries with cheaper labour, such as Eastern Europe and several Asian countries, these figures have dropped in many European countries. And here Finland is no exception.

[4]High technology sectors include the pharmaceuticals industry, computer and business machine manufacturing, data communication and related equipment, and the aerospace industry. Medium-high technology sectors include the manufacture of chemicals, machinery and equipment, vehicles, and electrical equipment and instruments.



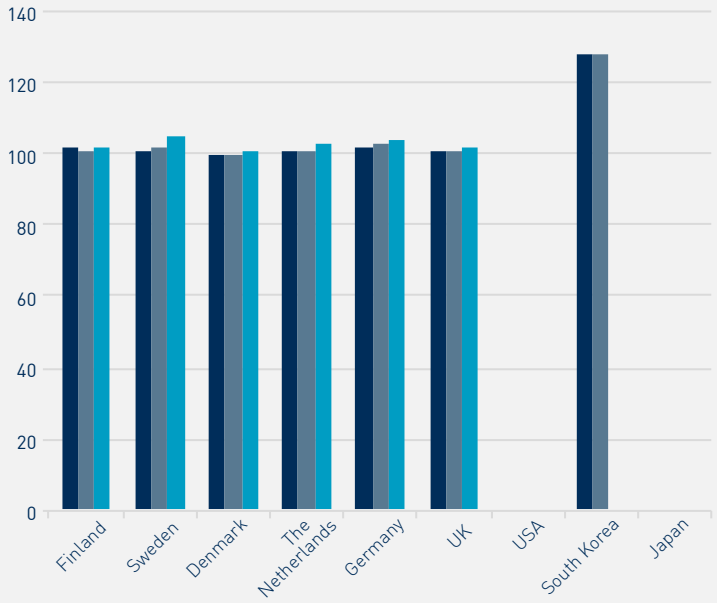
INDICATOR 3.3.

Number of patents granted by the USPTO



INDICATOR 3.4.

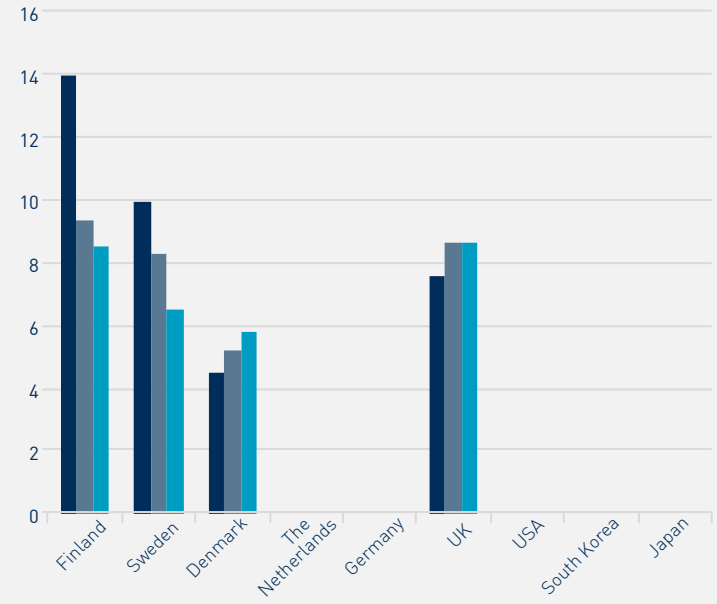
Scientific and technical journal articles (National Science Foundation).



INDICATOR 3.5.

Labour productivity per hour worked. ESA2010.

2011
2013
2015



INDICATOR 3.7.

Value added at factor cost, high and medium high technology manufacturing, % of GDP. (Eurostat).

2009
2011
2013

As an indicator of work productivity, the Technology Barometer uses the amount of GDP per working hour (adjusted for purchasing power, EU15 = 100) (Indicator 3.5). Work productivity was clearly the highest in South Korea in 2013 (data for 2015 unavailable). Work productivity has slightly grown in many of the reference group countries.

Indicator 3.5. Labour productivity (GDP per working hour), EU15 = 100 (Eurostat).

The Technology Barometer also includes an indicator that describes the production in high-technology sectors as a proportion of gross domestic product. Unfortunately, data for this was not available for most of the comparison countries. In 2013, Finland and the United Kingdom were at the top of the list on this indicator, but only four reference countries were part of it. It is notable that the trend towards increasing the value of high-technology production as a proportion of GDP is clearly growing in Denmark, whereas in Sweden it is clearly decreasing.

Indicator 3.7. Production value of high technology fields, percentage of GDP (Eurostat).

In analysing the proportion of exports accounted for by high technology (Indicator 3.8), South Korea was in the lead in 2010 and 2012, but also showed a downward trend (data on South Korea from 2014 was not available in time for inclusion in the present study). Of the European countries the Netherlands led, with Finland bringing up the rear. Excluding Denmark, the proportion of exports accounted for by high-technology production has decreased in all the reference countries from 2010 to 2014, which also contributes to Denmark's increasingly strong showing in innovation activity.

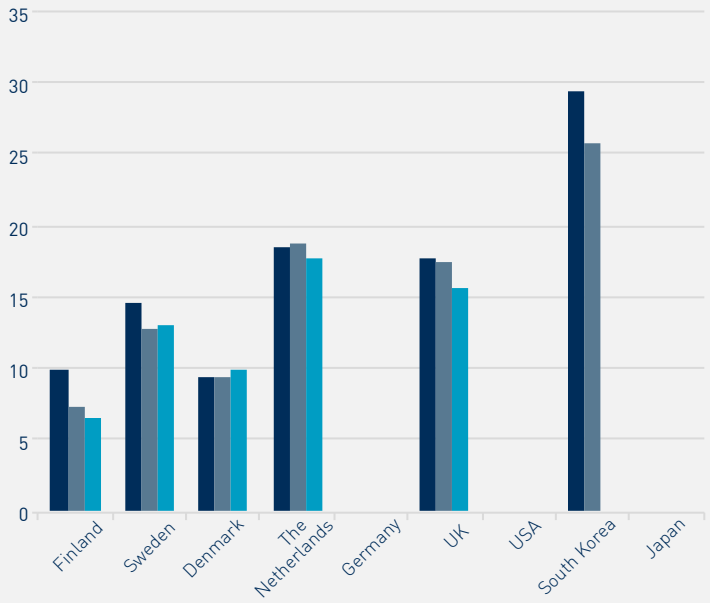
Indicator 3.8. High-technology exports, percentage of total exports (Eurostat).

Since 2010 the proportion of total industrial exports made up of high-technology production has dropped in Finland too, making it by 2014 the lowest-ranking of the comparison countries. South Korea was by a good margin the best-performing of the reference countries for the years examined.

Indicator 3.10. High-technology exports as a percentage of industrial exports.

The service business is undergoing an intensive process of internationalisation, which also means toughening competition and stiffer requirements for productivity and quality. In Finland, the provision of competence-intensive services, such as R&D and telecommunication services, has increased rapidly.[5] The data for proportion of GDP accounted for by market-determined expertise-intensive services was not available for many of the reference countries. In 2013 it was highest in the United Kingdom, at over 9 per cent, and second-highest in the Netherlands. This time around, the Technology Barometer also examines the proportion of service exports accounted for by ICT services, using Indicators 3.11 and 3.12 (ICT services more broadly defined). Finland placed strongly in the comparison. First we'll examine ICT service exports narrowly, and then more broadly.

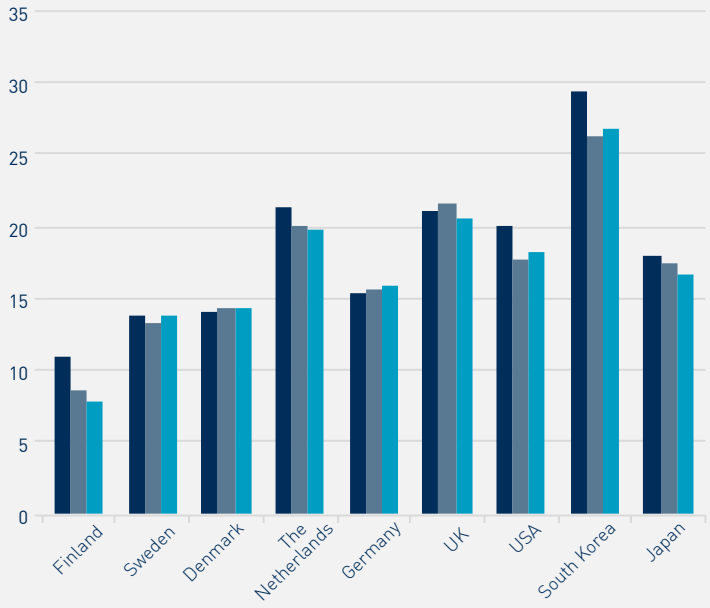
[5] In this connection, competence-intensive services include postal and telecommunications (sector 64), finance and insurance (sectors 65–67), research and development services, data communication services, and other business services.



INDICATOR 3.8.

High-technology exports (% of manufactured exports) (Eurostat).

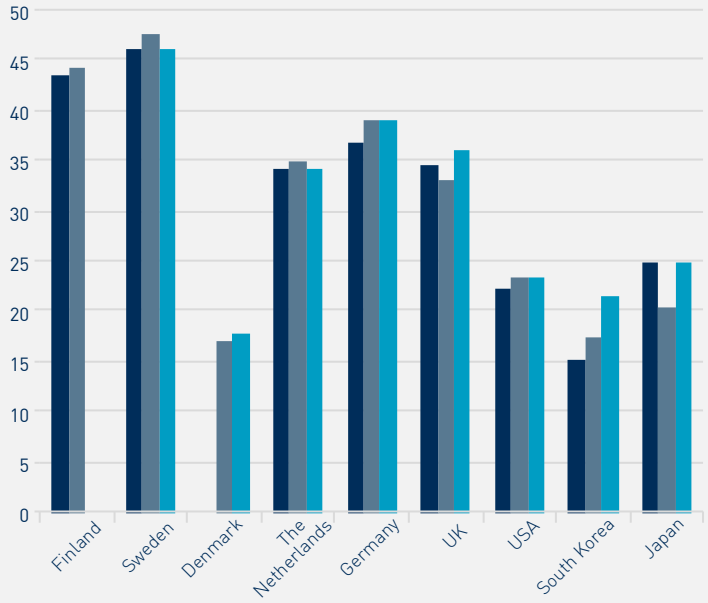
2010
2012
2014



INDICATOR 3.10.

High-technology exports (% of manufactured exports). (YK).

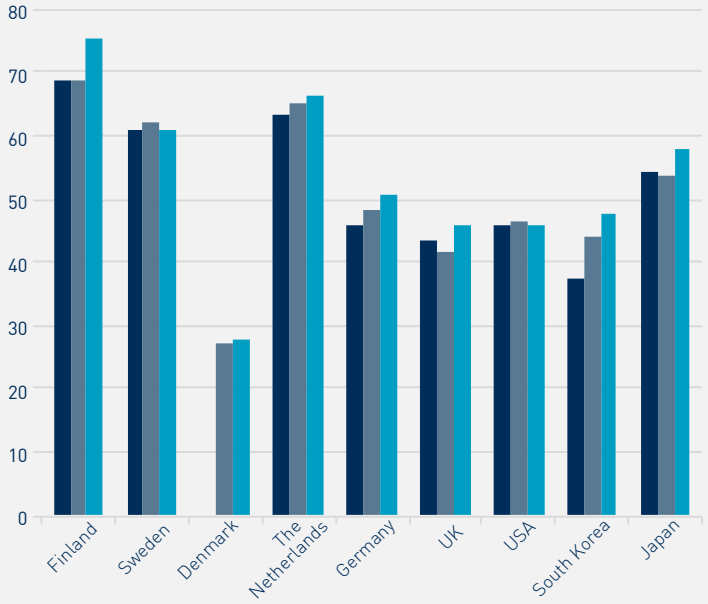
2010
2012
2014



INDICATOR 3.11.

ICT service exports
(% of service exports, BoP).
(IMF).

2010
2012
2014



INDICATOR 3.12.

Computer, communications
and other services
(% of commercial
service exports).
(IMF).

2010
2012
2014

Indicator 3.11. Information and telecommunication technology services exports, as a percentage of export services.[6]

Indicator 3.12. information and telecommunication technology services exports, extensive, as a percentage of export services.[7]

According to the most recent data from Statistics Finland (www.stat.fi/til/pul, 25.11.2016), exports of information-technology services from Finland have grown in the last two years by 46 per cent. 7.3 billion euros' worth of information-technology services were exported in 2015, when information-technology services accounted for over 40 per cent of company service exports. In all, companies exported services that year to the tune of 17.9 billion euros. Service imports the same year were 13.9 billion euros. In a 2014 report by the VATT Institute for Economic Research on the service economy in Finland (Honkatukia et al. 2014), analysis of the latest-available data suggested that the proportion of jobs requiring a high level of education and creating a high degree of added value would continue to grow. But, the study also concluded, most of these new jobs would be in service sectors, not in industry as had traditionally been the case. Moreover, according to the report that is central for Finland's economy and economic growth is that the services produced here (both products produced in the service fields proper and in service tasks related to industrial production) continue to be innovative and competitive. Those in charge of economic policy must understand that Finland is now

[6] Computer and communications services (telecommunications and postal and courier services) and information services (computer data and news-related service transactions).
[7] International telecommunications, and postal and courier services; computer data; news-related service transactions between residents and non-residents; construction services; royalties and license fees; miscellaneous business, professional, and technical services; and personal, cultural, and recreational services. International Monetary Fund, Balance of Payments Statistics Yearbook and data files.

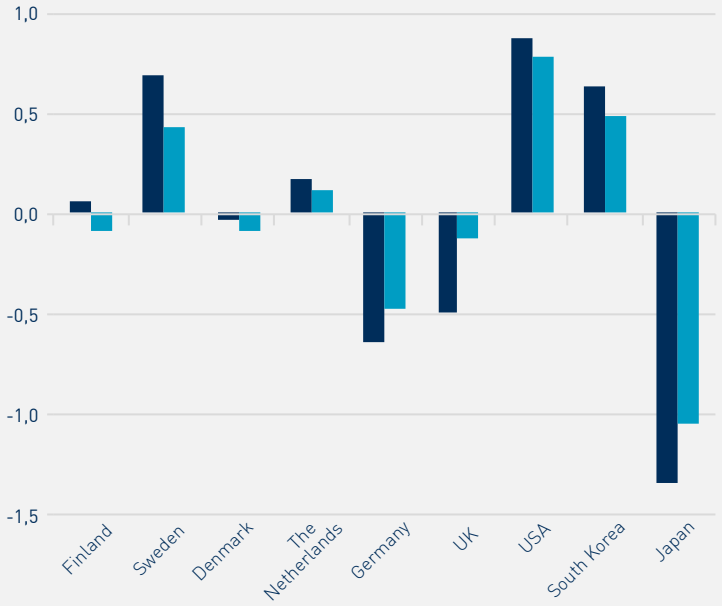
a service economy. There is no going back. Pining for the good old days of industrialised society will only cripple our development of service expertise and competitiveness.

Finland is now more attractive for foreign investments

The Technology Barometer uses five indicators to measure innovative entrepreneurship and economic regeneration. These indicate the level of the nation's entrepreneurial activity or people's willingness to establish a business – an independent enterprise or an employer-supported one – and their willingness to take the entrepreneurial risk, the GDP share of capital investments in nascent businesses, the share of informal investors, the share of new businesses, and the GDP share of fixed investments. The sources for these indicators consist of information collected by private companies and by public organisations. Little is known about the reliability and quality of the former source group. However, many indicators are based on this information because corresponding public information is not available.

In the combined index of entrepreneurship and economic regeneration, the US rates clearly first, South Korea second and Sweden third. The latter two have switched positions since the previous Barometer. Finland's placing in the comparison of nine reference countries is fifth, just slightly ahead of Denmark and the United Kingdom. Japan is clearly the weakest of this group on the combined index of entrepreneurship and regeneration of the economy. However, it must be said that all these nine countries have come closer together on this combined index over the last two years. That is, the best-performing countries have lost some ground, and the weaker ones are catching up. Especially strong development has been seen in the United Kingdom.

Indicator 3.25. The countries' proportional ranking in entrepreneurship and economic regeneration according to the GEM survey and measured with the GDP share of capital investments in new companies, share of new companies, and GDP share of fixed investments.



INDICATOR 3.25.

Relative ranking of the comparison countries on entrepreneurship and economic regeneration measured by the proportion of GDP accounted for by business capital investments, by the proportion of new businesses, the proportion of informal investors, and the degree of investment in the private sector.

TECHBaro2014
TECHBaro2016

The Global Entrepreneurship Monitor (GEM) is a consortium that investigates the capacity of various national economies to generate new businesses and support their growth. Entrepreneurial activity refers to that share of the adult population (16–64 years of age) that is actively seeking to begin or continue business operations. According to the GEM survey results, about 6.6 per cent of the Finnish working-aged adult population was actively engaged in starting or continuing entrepreneurial activities in 2015. In the United States, the corresponding figure is 11.9 per cent, in South Korea 9.3 and in Sweden and the Netherlands 7.3 per cent. In South Korea, entrepreneurial activity increased in the 2011–2015 period, as it did in Sweden, although in the latter there has been a slight decrease since 2013. On the other hand, in the other comparison countries entrepreneurial activity has either decreased or stayed the same in the 2011–2015 period.

The indicator of number of work phases needed for recruitment in new businesses is a measure of the complexity or straightforwardness of founding a new business in the country in question. The top three comparison countries here are Finland, Sweden, and South Korea. The relatively light permit practices in the Nordic countries has continued for a long time now. In South Korea there has been a remarkable development in simplifying the process of founding a business. Still in 2008 no fewer than ten work stages were needed. Perhaps the need for reducing bureaucracy in order to start a business has partly spurred the evident growth in entrepreneurial activity in that country?

In terms of the share of informal investors among the adult population, Finland rates sixth among the reference group countries. It is notable too that Sweden, which topped the list of comparison countries in 2013, has not dropped to Germany's level. Both are now only marginally above the other Western European countries - excluding the UK, where the number of informal investors has been dropping sharply for several years now. The number of informal investors in the US dropped after the financial crisis, but has remained stable since then.

The Rate of starting new businesses indicator measures the percentage of new businesses among the total number of enterprises. The Technology Barometer uses this indicator to measure a nation's capacity for economic regeneration. The dynamics of the business enterprise sector can be regarded as a central factor in a strong economy.

Unfortunately, the rate of starting new businesses in Finland has dropped in recent years. In 2013, the share of new companies from all those currently in operation was the fifth highest in Finland, around 6.1 per cent. The leading countries were the United Kingdom and South Korea, with around 14 per cent in each. The UK is also the only one of the comparison group in which the proportion of new businesses grew in the 2011–2013 period. The proportion of new companies there has grown greatly since 2009, whereas in the other comparison countries the share has either remained stagnant or fallen. It is in Finland that the decline has been most marked.

On the other hand, Finland's economic development may be in store for a brighter future on account of flagship company, Nokia, once again creating added value on the same scale as a decade ago. Figure 5 shows how much added value Nokia produced per employee (in thousands of euros) in recent years. Calculations of added value include salaries paid and the company's operating margin, i.e. its business result, to which is added deductions and depreciations in value.

Figure 5. Added value created by Nokia per employee (in thousands of euros) in recent years.

In the Technology Barometer, the investment rate of a national economy is measured by the private sector's share of fixed capital investments of GDP. In 2015, Finland ranked second on degree of investment in the private sector, a joint second with Germany at 20 per cent. Ahead of them was Sweden. Sweden and Germany are the only countries of the comparison group in which the private-sector degree of investment has not fallen from the 2008 level. Finland's private sector degree of investment was then the highest of all the comparison countries, at 25 per cent. No data is available for the US, South Korea, or Japan.

Company investments in R&D information and telecommunications technology, environmental technology, and energy technologies are on the increase

Business representatives were asked which technologies their enterprise invested in during 2016. The results are shown in Figure 2.12. The comparison between 2016 and 2011 indicates that investments seem to have increased in electronics, manufacturing technologies, environmental technology, and energy technology. Environmental technology and energy technology investments have been at a high level since 2011, but investments in computing and communications technology have grown strongly. Construction technology has also taken a good leap upward, which may be related to the high number of large-scale infrastructure projects now underway in Finland.

Survey graph 2.12. Product development investment trends. (Question presented: Below are a list of areas in which new technologies are currently being developed. How do you see your enterprise's R&D investments development in each field of investment during the next 6 months in relation to the general development of your enterprise's R&D investments? 1 = The technology in question is not part of our business, 2 = We will invest considerably below average, 2 = We will invest below average, 3 = Difficult to say, 4 = We will invest above average, 5 = We will invest considerably above average).

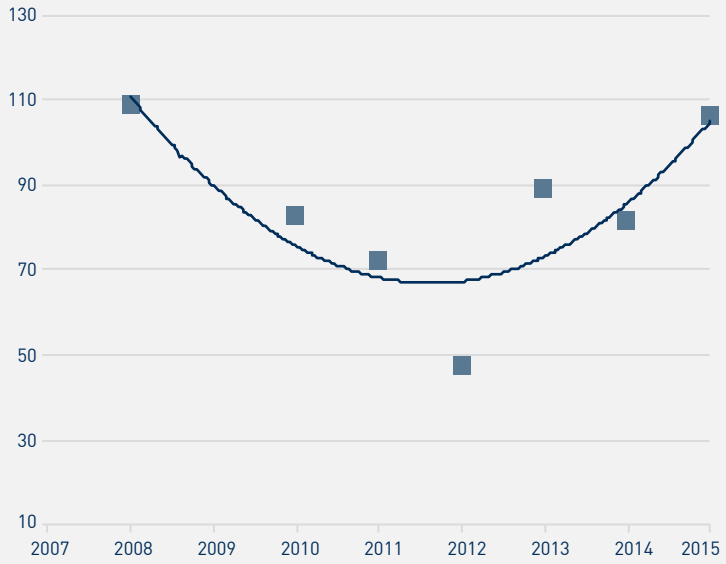
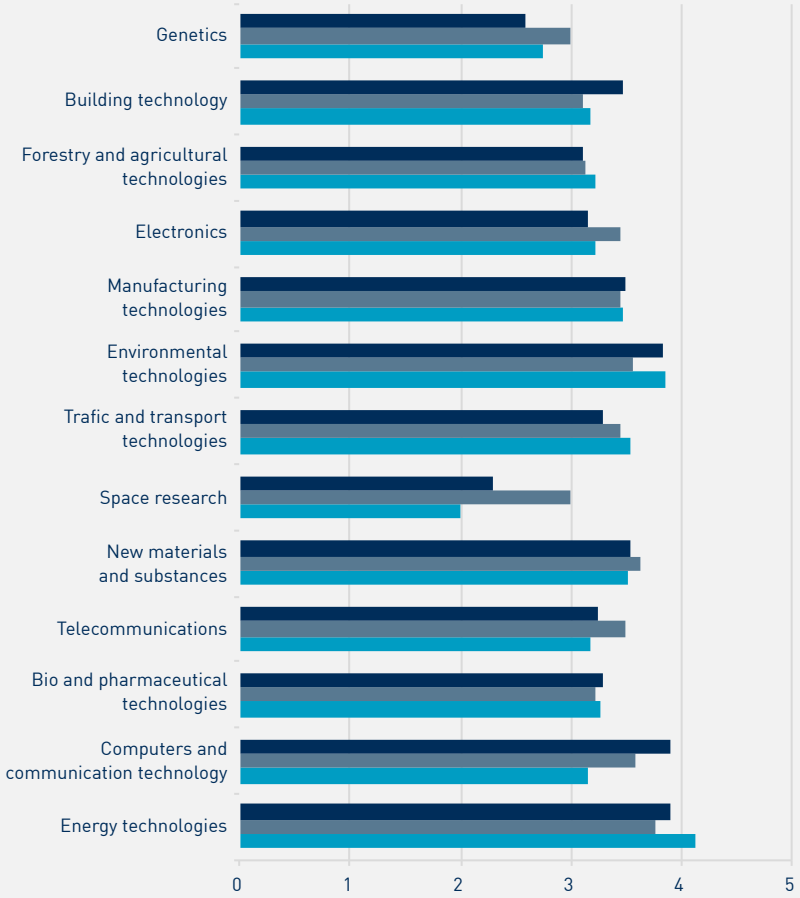


FIGURE 5.

Added value created by Nokia per employee (in thousands of euros) in recent years.



SURVEY GRAPH 2.12

Product development investment trends.

(Question presented: The following is a list of fields that are currently developing new technology. How do you see your enterprise's R&D investments development in each field of investment during the next 6 months in relation to the general development of your enterprise's R&D investments?

1 = The technology in question is not included in our business,
2 = We will invest considerably below the average,
3 = We will invest below the average,
4 = Difficult to say,
5 = We will invest above the average,
6 = We will invest considerably above the average).

Biotechnology, environmental technology and energy technologies improve the standard of living

In the 2016 measurements, TEK members and politicians assess the technologies that they think will contribute to raising living standards over the next 20 years. Their top choices were biotechnology, environmental technology, and energy technology. The estimates of both the members and the politicians in all these areas have improved steadily in every study done so far, i.e. in 2011, 2014, and now in 2016. The estimates of the influence of other technologies are slightly lower, but apart from space research, which is difficult to assess, they are believed to have a positive effect on the quality of life. Confidence in the life-improving effects of construction techniques has waned in recent years, however, both among TEK members and politicians.

Excluding telecommunication and forestry and agricultural technologies, TEK membership and politicians largely shared a similar view of technologies' positive effect on the quality of life in 2016. An important exception is genetics, for which politicians have higher hopes than TEK members do.

Finland now more networked and international

The combined networking and openness index has a clear leader, namely the Netherlands. Finland has risen steadily to the top of the Nordic countries, and is overall second only to the Netherlands. The change is significant, since in the 2012 Technology Barometer Finland ranked fifth in the comparison group of countries. Sweden has dropped from first to third place. Japan, South Korea, the US and Germany were the laggards of the group.

Indicator 3.26. Relative ranking of the comparison countries on network creation and internationality, measured by proportion of GDP accounted for by direct foreign investments, foreign private investments in R&D, and openness of trade.

Network creation and internationality are measured in the Technology Barometer with six indicators. These are the GDP percentage of outbound and inbound investment stocks and the total level of these two cross-border investment types, the GDP percentage of foreign R&D investments and openness to international trade regarding both products and services.

The amount of inbound direct foreign investment stocks could be higher in Finland. Practically every year, starting from the mid-1980s, outbound direct investment stocks from Finland to other countries have considerably exceeded the level of investments made in the opposite direction. Finland has, however, improved its position in recent years: The amount of foreign direct investments in to Finland has grown, as has the proportion of R&D investments that come from foreign funding. The latter "improvement", though, is partly an optical illusion, namely the result of the aforementioned reduction in domestic investments in R&D.

In 2015, the GDP share of average inbound and outbound direct investment stocks was highest by far in the Netherlands, at almost 25 per cent. Following it were three Nordic countries, with Finland heading them with 8.9 per cent. In the largest economies the development has been largely stable, except for the United Kingdom, where the Brexit referendum has created uncertainty that is likely affecting investor behaviour.

In 2015 the amount of outbound direct investments was clearly greatest in the Netherlands, at 157 per cent. The corresponding figure for Denmark was 68 per cent. The data on this for Sweden in 2015 were not available, but in 2014 stood at 81 per cent. Excluding the UK, then, a somewhat varying upward trend could be seen in all of the compared countries between 2008 and 2015. The amount of outbound investments as a share of GDP grew in Finland from 44 to 57 per cent in the 2008–2010 interval, but since then has remained entirely stable, or stagnant.

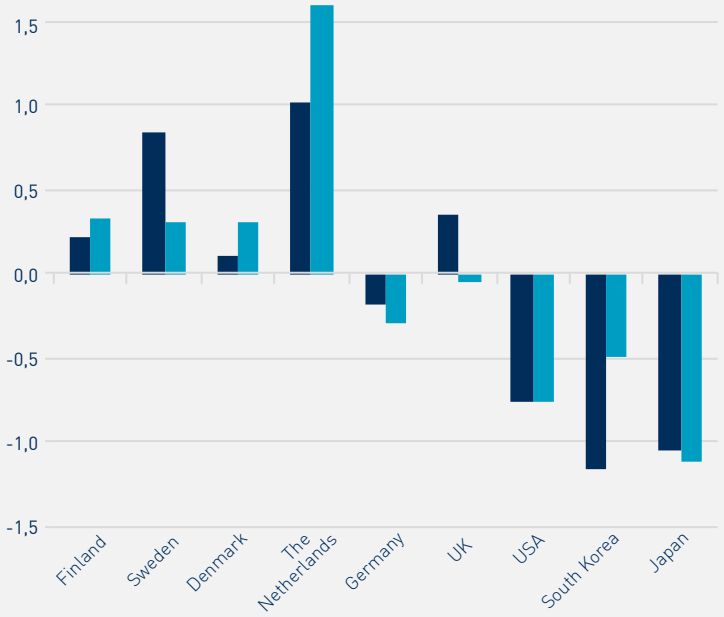
In 2014, in the GDP share of inbound direct investment stocks the Netherlands was tops, with 108 per cent, the United Kingdom second with 72 per cent, and Sweden third with 66 per cent. In 2015 the UK's share fell, however, to 61 per cent. The amount of inbound direct investments grew in the UK steadily throughout the 2008–2013 period before starting to decline. Finland's ranking in the comparison group was fourth, behind Denmark. In the 2012–2015 period, direct investment in Finland as a proportion of GDP has grown, whereas in Denmark it has fallen. This trend has continued in the same vein since 2008.

Foreign companies' share of R&D investments in the business enterprise sector aims to measure the nation's success in international expert networks. In 2013, Finland was the leading country among the reference group of countries in terms of attracting foreign R&D investment, with a 0.38 per cent share. This development has continued strongly, because already in 2014 the proportion was 0.55 per cent. Although foreign investments in the United Kingdom have been generally on a downward trend, when it comes to R&D investments this is not the case. Instead, the proportion of foreign investments in research and development into the UK has remained at about 0.3 per cent of GDP. In Sweden, by contrast, the proportion shrunk from the 2009–2011 level of 0.36 per cent of GDP to 0.22 per cent in 2014.

Figure 6. The proportion of private-sector R&D investments accounted for by foreign funding, as a as a percentage of GDP (Eurostat).

A country's openness to international trade is measured using two indicators. These focus on the proportional share of foreign trade (i.e. imports and exports) of GDP. One of the indicators highlights the exchange of products, and the other that of services. When the proportional share of foreign trade of GDP increases over time, this can be interpreted as the national economy's increasing integration with the world economy.

On openness of trade, the Netherlands was clearly number one in 2013. Finland's rating is fifth in the reference group, clearly behind Germany but level with Denmark and Sweden. Sweden is the only country of the comparison group where the openness of commerce has decreased since 2009. In 2013, the share of GDP accounted for by foreign trade was 29 per cent in Finland. In 2013, Finland ranked fourth in terms of open service provision, with 12 per cent. Denmark was the undisputed leader with its 20 per cent of GDP, the Netherlands second and Sweden third.



INDICATOR 3.26.

Relative ranking of the comparison countries on networking and internationality measured by the proportion of GDP accounted for by foreign direct investments, the proportion of GDP accounted for by foreign financing in R&D in the business sector, and by the openness of trade.

TECHBaro2014
TECHBaro2016

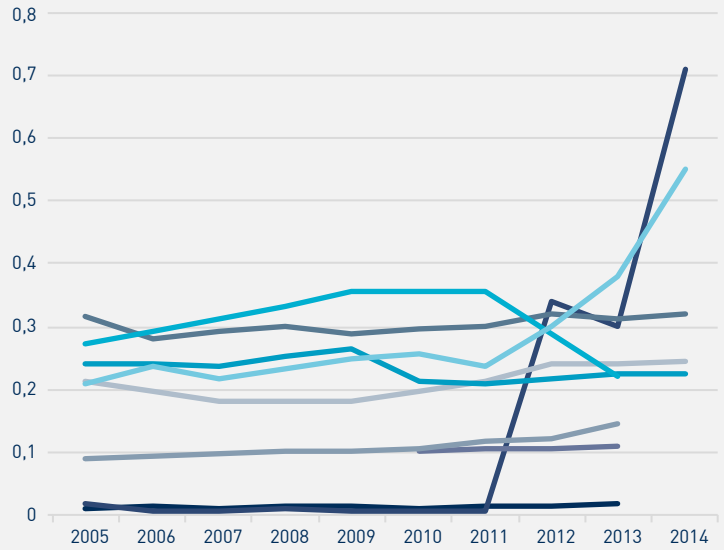
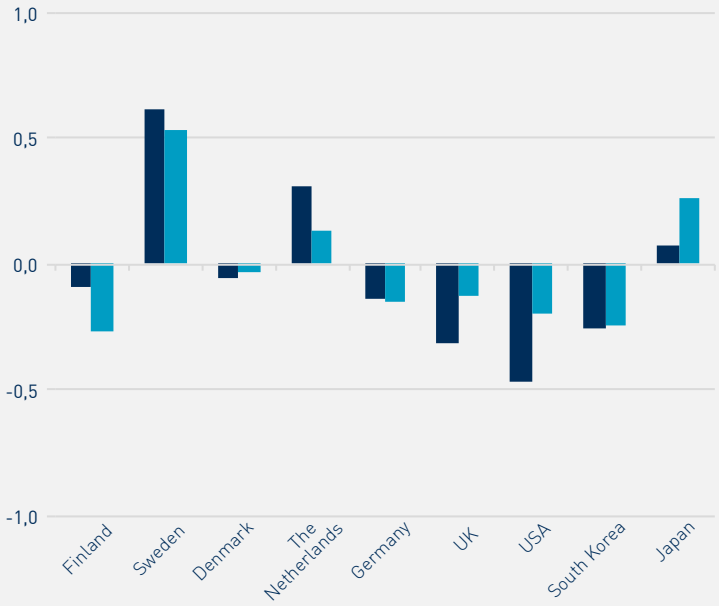


FIGURE 6.

Share of foreign funding in R&D investments in the business sector as a percentage of GDP (Eurostat).



INDICATOR 4.33.

Relative ranking of the comparison countries on citizens' health, income distribution, employment rate, and equality between the sexes.

TECHBaro2014
TECHBaro2016

3.4 Sustainable development society: Lacklustre improvement in the employment rate has dragged Finland down to the tail end of the ranking

Wellbeing indicators show Sweden to be still the leader

Indicator 4.33 describes Finland's relative placement in the group of comparison countries measured on indicators relating to social equality. The indicators show that Finland is weakest on most of the indicators in this area. Compared to the 2014 Technology Barometer, Finland has dropped from mid-level to the bottom. There has been a clearly discernible positive change in the US, UK and Japan on the combined indicator of social equality between 2014 and 2017. In the cases of the US and UK, the change is explained above all by those countries' developments in reducing unemployment. Finland's weakened standing is, conversely, due to the negative trend in unemployment. But on indicators of income distribution, risk of poverty after income distribution, and equality between the sexes, Finland is largely above average among the comparison countries, and the developments in these areas over time have been positive.

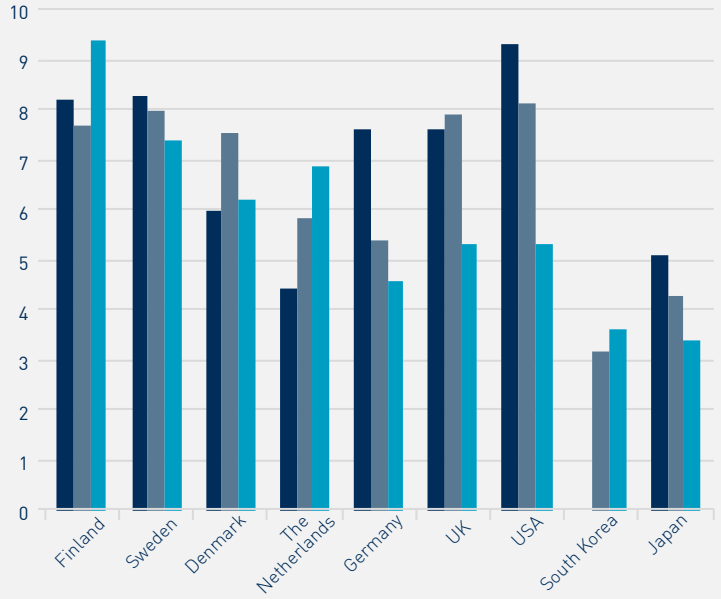
Indicator 4.33. Relative ranking of the comparison countries on citizens' health, income distribution, employment rate, and equality between the sexes.

Indicator 4.10 shows that the unemployment rate in Finland has once again grown, after the very slight drop of the two previous Barometers. It is not highest of all the comparison countries, at 9.4%. The only other countries of the comparison group in which unemployment is also on

the rise are the Netherlands and South Korea. In the latter however, the increase has been very small. In some of the countries the drop in unemployment rate over the period examined has been considerable, as in Germany (from 7.6 to 4.6 per cent), the United Kingdom (7.9 per cent to 5.3 per cent), and the United States (9.3 per cent to 5.3 per cent). In the UK, though, the decrease only began during the time covered by the two previous Barometers.

Indicator 4.10 Unemployment rate, percentage (Eurostat).

Indicator 4.12 describes long-term unemployment and so provides information on the structure of unemployment in the reference countries. Finland and the Netherlands are countries where the proportion of long-term unemployed has grown over the entire period examined. In the other countries, the situation has either stayed the same or improved during the last two measurement periods at least. The proportion of long-term unemployment usually drops at the beginning of a recession, because of the growth in the overall number of unemployed. When economic growth picks up again, the proportion of long-term unemployed increases, since those who suffered from cyclical employment find work, leaving the others behind. If the amount of long-term unemployed and hard-to-employ people remains high for an extended time, there is a correspondingly larger risk that their chronic unemployment will become a structural problem. Structural unemployment refers to a state of affairs in which the functionality of labour markets has deteriorated to the point that workforce supply and demand no longer meet. In such a situation, there are many unemployed and many vacant positions at the same time. According to a study by the State body the VATT Institute for Economic Research, the risk of structural unemployment has grown in Finland in recent years (Obstbaum and Tuomala, 2015).



INDICATOR 4.10.

Unemployment rate, total, % (Eurostat).

Finland's long-term unemployment still growing

If Finland's situation is examined in light of the aforementioned indicators, there are clear indications of this: The proportion of long-term unemployed has grown in Finland at the same time as the overall unemployment rate has grown; that is, the actual number of long-term unemployed must have been, and likely must continue to be, growing at a higher rate than cyclical unemployment. In the United Kingdom and the US, the change in the proportion of long-term unemployed points more to unemployment resulting from cyclical changes. That is, the growth in long-term unemployment in those countries is due to the reduction in the overall unemployment rate. In those two countries, then, over the preceding two comparison periods the proportion of long-term unemployed has fallen. Because unemployment overall has decreased, it seems that periods of unemployment in those countries must have been for the most part shorter than in the other comparison countries. (It must be noted here that the years for which the indicators were examined were not the same, so the comparisons between countries are somewhat sketchy).

Indicator 4.12 Proportion of long-term unemployed, per cent (Eurostat).

The materials analysed for the Barometer offer an interesting view of the development of the labour markets in Germany. For the period under examination there has been a very strong positive trajectory in Germany in all the indicators related to employment: The employment rate grew in the 2008–2014 period from 70 per cent to 77.4 per cent (Indicator 4.8), and the employment rate of older people rose over the same period from 57.7 per cent to 65.6 per cent (Indicator 4.9). In the 2009–2015 period, the unemployment rate in Germany has dropped from 7.6 per cent to 4.6 per cent (Indicator 4.10), and both youth unemployment (Indicator 4.11) and long-term unemployment (Indicator 4.12) have dropped throughout the period being examined. However, it was noticed from the combined indicator (Indicator 4.33) that measured on social cohesion the overall situation in Germany has, despite the positive employment trend, worsened over the 2014–2016 period. This puts Germany in sixth place among the comparison countries, nine of which were compared on this indicator. This direction of development means, then, that Germany has at the same time as its positive trend in employment an overall trend in social harmony that is going in the opposite direction, i.e. the country is becoming less cohesive as a society. From the available indicator material it is of course not possible to make any sweeping generalisations about social developments in Germany, but Indicators 4.5 and 4.7 do give at least some inkling of what is going on. The ration indicating division of labour (Indicator 4.5) compares those in the top 20% on earnings to those in the bottom 20%. The larger the disparity between the two, i.e. the further the ratio is below 1, the broader is the overall spectrum of income inequality in the country in question. This ratio has been growing in Germany since 2008, and is higher than in any of the Nordic countries. The risk of poverty after income redistribution (Indicator 4.7) has also increased in Germany since 2008, and in 2014 was at 16.7%. This figure represents the proportion of people who after receipt of social benefits still have a disposable income of less than 60% of the national median. For Finland this was 12.8% in 2014.

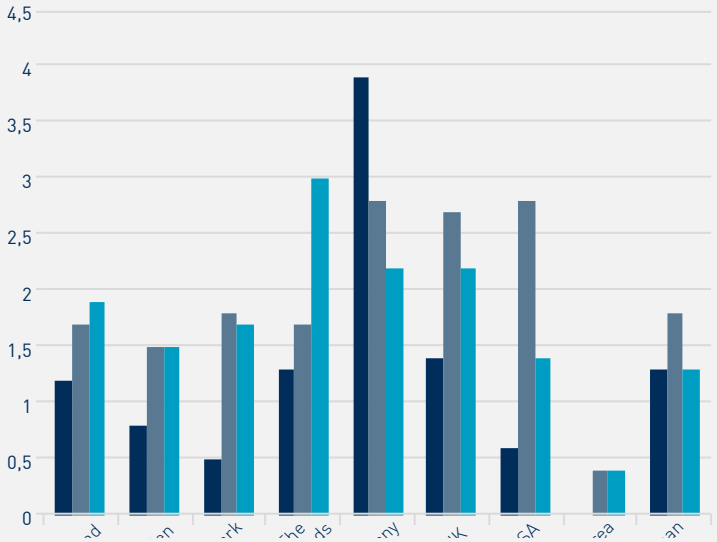
Indicator 4.5. Income distribution ratio (Eurostat).

Indicator 4.7. Poverty risk after social income transfers, per cent (Eurostat).

In the 2003–2005 period Germany implemented a broad programme of labour market reforms, the main elements of which were renewal of employment services, activation of the unemployed, and deregulation of labour markets. The reforms were implemented on the basis of four separate laws, which were dubbed the Hartz laws after the chair of the programme's working group, Peter Hartz. The laws brought large changes in unemployment benefits and employment support and jobseeking services, weakened terms of employment, and removed various obstacles to entering the workforce. There is no doubt that labour market reforms improved the employment situation in Germany. However, critics argue that the reforms saddled the country with newly-created markets for irregular employment relations. These, it is argued, made working life in Germany more precarious and led to the creation of a new class, the working poor, i.e. those whose earnings are not enough to get by on and must be supplemented by social benefits if they are to survive. One sign of this is that German labour markets were introduced to a new concept, so-called miniwork. This refers to work providing a monthly income of less than €450, which - if it is the person's only source of income - is exempt from social security charges and from taxation. Miniwork originally meant either the possibility to make supplementary earnings, for instance for students working part-time, or for pensioners or those who have difficulty in finding stable employment. As such, for these groups miniwork used to provide a bridge of sorts connecting them to the labour market. In practice, however, it has turned out that women are disproportionately highly represented among those who have been relegated to the miniwork market. Rather than providing a bridge to potentially better earnings by creating access to the labour market, miniwork has become an obstacle to full- or even part-time unemployment. Of all those subsisting on miniwork in Germany, over two-thirds are women, and over 60 per cent of those women have no other income. Added to that is the fact that the average duration of women's minijobs is over 6.5 years, and that considerably more women (60%) leave the labour market altogether after their time in miniwork than gain full-time employment (14%) (Schmöller, 2013).

Indicator 4.11 Proportion of young unemployed, per cent (Eurostat).

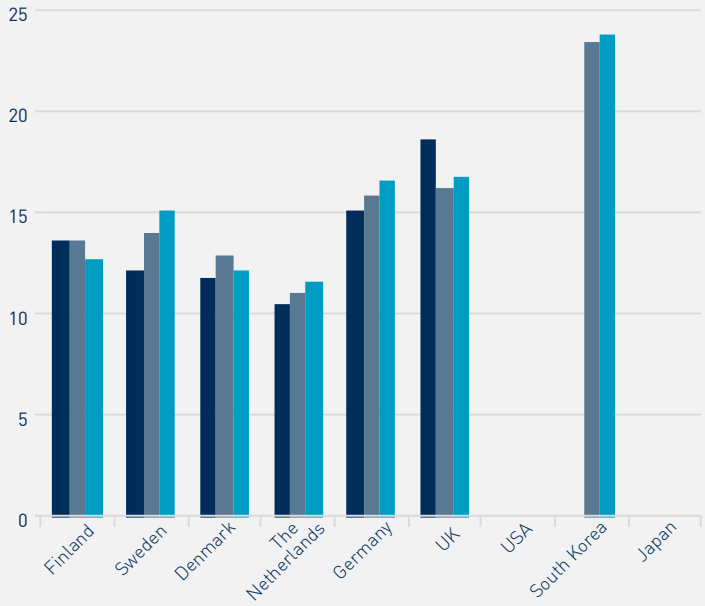
The second graph describing the structure of unemployment shows the proportion of total unemployment in the comparison countries accounted for by youth unemployment (Indicator 4.11). In this indicator, Finland's relative position looks weak. In practice, though, this is due to a



INDICATOR 4.12.

Long-term unemployment by sex - annual average, % of active population (Eurostat).

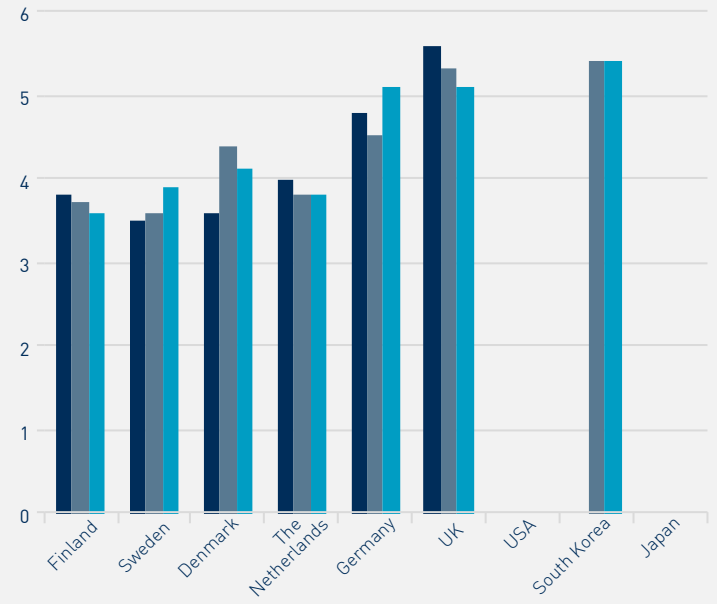
2008
2011
2014



INDICATOR 4.7.

At-risk-of-poverty rate after social transfers (Eurostat).

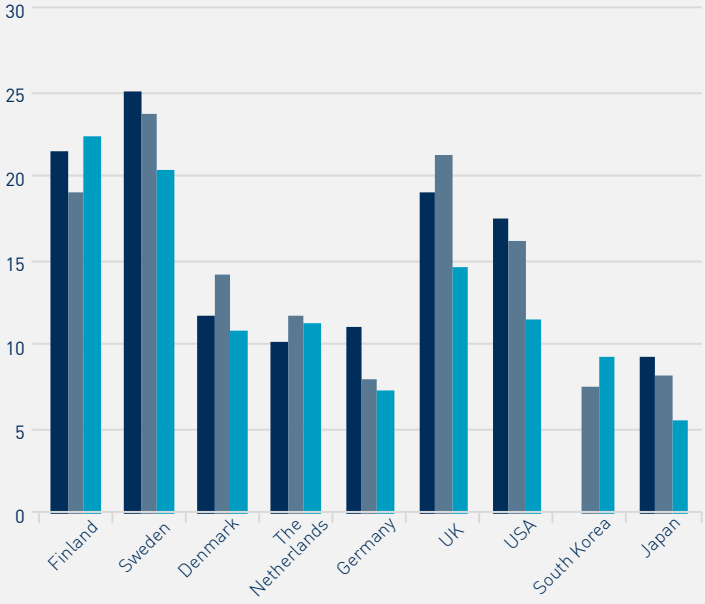
2008
2011
2014



INDICATOR 4.5.

Inequality of income distribution, income quintale share ratio (Eurostat).

2008
2011
2014



INDICATOR 4.11.

Unemployment rate, persons aged less than 25 years, % (Eurostat).

2009
2012
2015

statistical kink concerning the method of compiling the statistical data and also the fact that the education systems in the comparison countries can differ significantly from each other (Hämäläinen & Tuomala, 2013). In calculating the unemployment rate, the class of the unemployed encompasses all those who have self-identified in labour market surveys as being either without work, seeking work, or willing to accept work. This being so, in Finland and Sweden - two countries where it is very common for students to work part-time - the class of the unemployed includes many students who are seeking only part-time work and are not strictly speaking unemployed. Another factor that makes this indicator slightly skewed is that the unemployment rate does not describe the amount of unemployed people relative to age group, but instead relative to the total number of people who are employed. The labour force, then, consists of both the employed and the unemployed. This statistical factor may also contribute to some extent to the observed differences between the comparison countries on these questions. For instance in Germany, Denmark and the Netherlands, all of in which apprenticeship contract training is a common route to a profession, the apprentices are classified as employed persons (Honkatutkia et al., 2014). In Finland, by contrast, where professional training overwhelmingly takes places in colleges and universities, whether the people involved identify as employed or unemployed is something of a subjective matter. That is, it mostly depends on whether they have part-time employment at the time of responding to labour market surveys. For this reason part of the age group to which most students belong is left entirely outside the workforce, and so the divisor of the indicator representing the unemployment rate is smaller than it would be in, say Germany, Denmark, or the Netherlands. As a result, countries like Finland and Sweden look like they have a higher unemployment rate than would be the case if the situation concerning students was different.

One view that can be taken away from this is that for it to be possible to draw any insightful conclusions on youth unemployment across the comparison countries, more data would be needed. For example, it would be important to distinguish in the statistics between unemployment of youth who are not studying, and to proportionalise the amount of unemployed people to the whole age group rather than just to the labour of the age group in question. A case in point is that in 2012, youth (aged 20–24) unemployment in Finland was 19% (Indicator 4.11), but the unemployment rate of non-studying youth in that age cohort was a bit over 5% (Hämäläinen & Tuomala, 2013). In Indicator 4.11, it is indeed more relevant to focus on examining the change than on the levels it is at across the various countries. From this perspective, Finland's situation is getting worse relative to the comparison countries: aside from South Korea, Finland is the only one of them in which youth unemployment has increased in two consecutive periods of examination. In the Netherlands, for instance, there is very little sign of any marked change over the same time, and over the period of the last two studies there has been a downward trend. And in the Netherlands the trend in long-term unemployment overall continues to be negative.

Without reference to any particular country, it is worth noting that youth unemployment has in practice always been higher than for the rest of the adult population (Hämäläinen & Tuomala, 2013). What explains this is that youth have not yet had time to consolidate their position in the labour market, and so it is common for there to be short breaks in employment between jobs. Another characteristic of the youth unemployment rate is very pronounced seasonal variation, when education ends just before the summer and a large number of jobseekers emerge more or less all at once. Youth are however a special group when it comes to labour-policy measures, since unemployment during one's early adulthood can have more far-reaching consequences than later in life. In this regard, over the past few years there has been a lot of talk about the "youth guarantee". This is a programme that came into force in Finland from the beginning of 2013, and in it each youth (below 25 years of age) and young new graduates below the age of 30 are guaranteed a position of some kind within three months of having registered as an unemployed jobseeker. The place can be a study place, an apprenticeship position, a rehabilitative position, or paid employment.[8]

Sweden number one also in employing older people

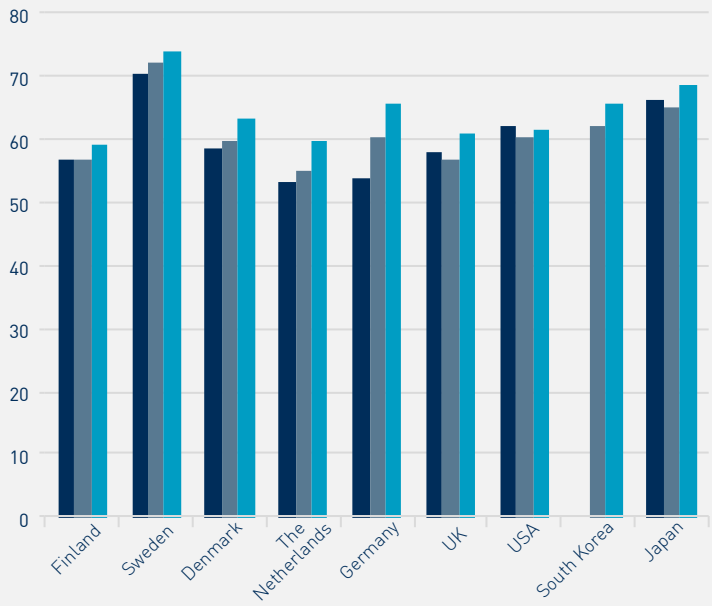
At the other end of the working-life continuum are older employees. Their employment rate in the comparison countries is shown in Indicator 4.9. It can be seen from it that in Germany, for one, there has been a great improvement in employment of older people. The change in the 2008–2014 period has been almost 12 percentage points (53.7 to 65.6 per cent). The corresponding change in Finland for the same period is only around 2.5 per cent, and in 2014 the employment rate of older workers was 59.1%. The labour market reforms implemented in Germany have presumably had a positive effect to some degree on the country's improved situation. But Sweden stands out here in an interesting way from the reference countries, in that there the employment rate of older people is clearly higher across the entire period of study. In 2014, for instance, the employment rate of older people in Sweden was 70.1%, almost 15 percentage points ahead of Finland. This phenomenon is mostly likely explicable by the fact that in Sweden there is a law on how seniority can and cannot be taken into account in situations where an employer has a desire or need to lay off staff. This law requires that when such a situation arises for economic reasons, the layoffs must be implemented in increasing order of seniority. In other words, those employees who have been with the company longest have better legal protection against becoming unemployed. This is therefore a clear example of what's called a last-in-first-out policy on layoffs. In a comparative study of employment relations in multinational companies in Sweden and Finland (Skedinger, 2016), it was found that a longer period of employment in the same workplace had an effect on one's prospects for continuing employment in Finland that differed from those in Sweden. In Sweden, those in longer-term employment

[8] www.nuorisotakuu.fi/tietoa_takuusta

had a noticeably lower likelihood of being laid off than in Finland. The effects of seniority on one's likelihood of becoming unemployed comes strongly to the fore in companies that are downsizing. In stable or expanding companies, by contrast, there is no real difference between the comparison countries. For some older workers it may well be that rather than being layoffs, the employment relationships could be assumed to end on the initiative of the employee him- or herself.

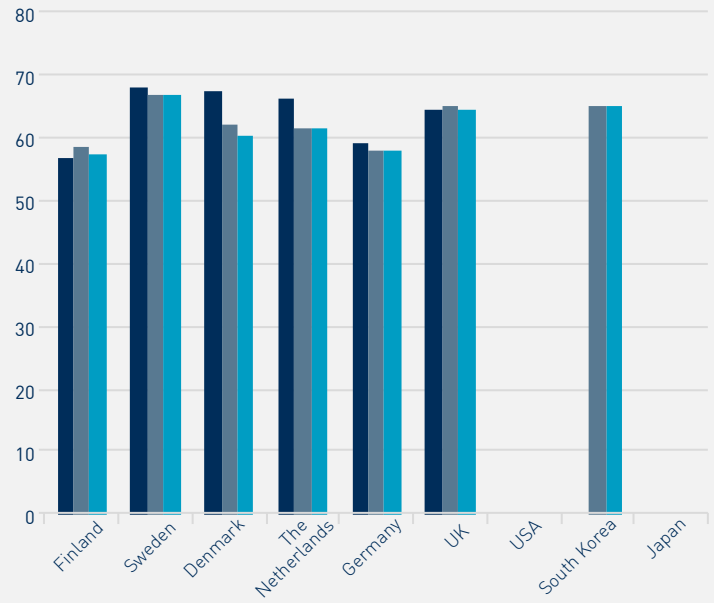
Indicator 4.9 Employment rate among older people, as a percentage of the 55–64 age group (Eurostat).

Employment rate and labour market usefulness have central roles in the wellbeing of any society. The indicator data used in the Technology Barometers offer an interesting viewpoint on the labour markets in the different countries. Going beneath the surface of these matters reveals the differences between them in the structure and function of their labour market systems and their employment situations. Some of these differences can give rise to statistical errors, the risk of which adds some difficulty to interpreting and making comparisons with the indicators. One example of such a challenge of interpretation is the effect of the education system and student's employment status on the statistics for youth unemployment in Finland and Sweden. On the other hand, indicator data can show a convincingly positive development in some other country that Finland might do well to adapt and adopt in response to its current troubles. But the labour markets form such a complex whole, and are so intricately integrated into the whole social structure of a country, that there is no guarantee that a solution developed to work well in context would prove beneficial in some other, quite different country. Although caution is prudent, however, one can risk making too much of it: after all, reforms by their very nature contain an element of unpredictability. But they could in some cases bring about the possibility of failure or unforeseen and perhaps undesirable side-effects. One salutary example of this is the labour market reforms



INDICATOR 4.9.

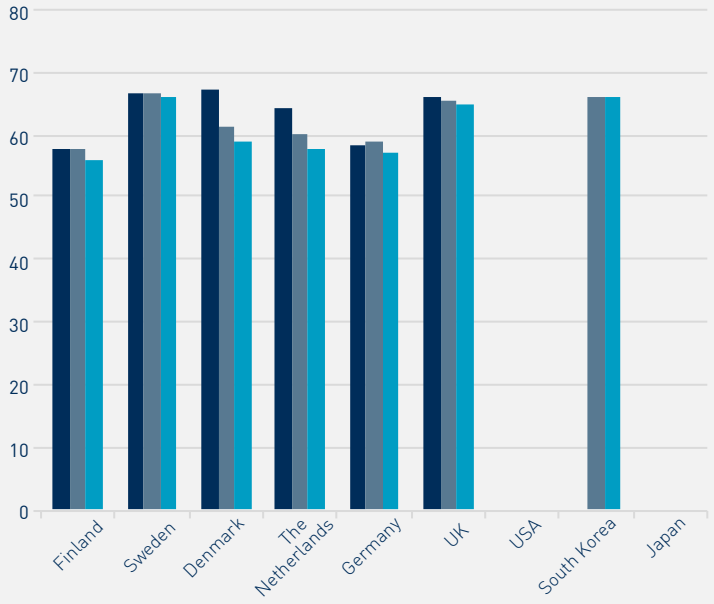
Employment rate of older workers, persons aged 55-64, % (Eurostat).



INDICATOR 4.3.

Healthy Life Years at birth, males (Eurostat).

2007
2010
2013



INDICATOR 4.4.

Healthy Life Years at birth, females (Eurostat).

2007
2010
2013

undertaken in Germany in the 2000s, which gave rise to what has been called the German "unemployment miracle" (Kauhanen, 2012). In light of statistical analyses, this "miracle" has increased economic and social inequality in the country.

Healthy life expectancy is dropping in all the comparison countries, Finland included

In 2014, the life expectancy from the moment of birth was 78.4 for men and 84.1 for women. Both figures show an increase of around half a year on the expectancies given in the 2012 Technology Barometer. However, there has been no such increase in the healthy life expectancy. On the contrary, this is decreasing in all the countries examined. In December 2016 in the United States, the National Institutes of Health announced that the life expectancy had dropped for the first time since 1993, when the AIDS epidemic was at its worst. The decrease is only about one month, from an average of the two sexes from 78.9 to 78.8 years. Although too much should not be read into such a small change, based on analysis of the life expectancy trends for the countries covered in the Technology Barometers it is fair to say that it is less likely than before that one's final years will be healthy.

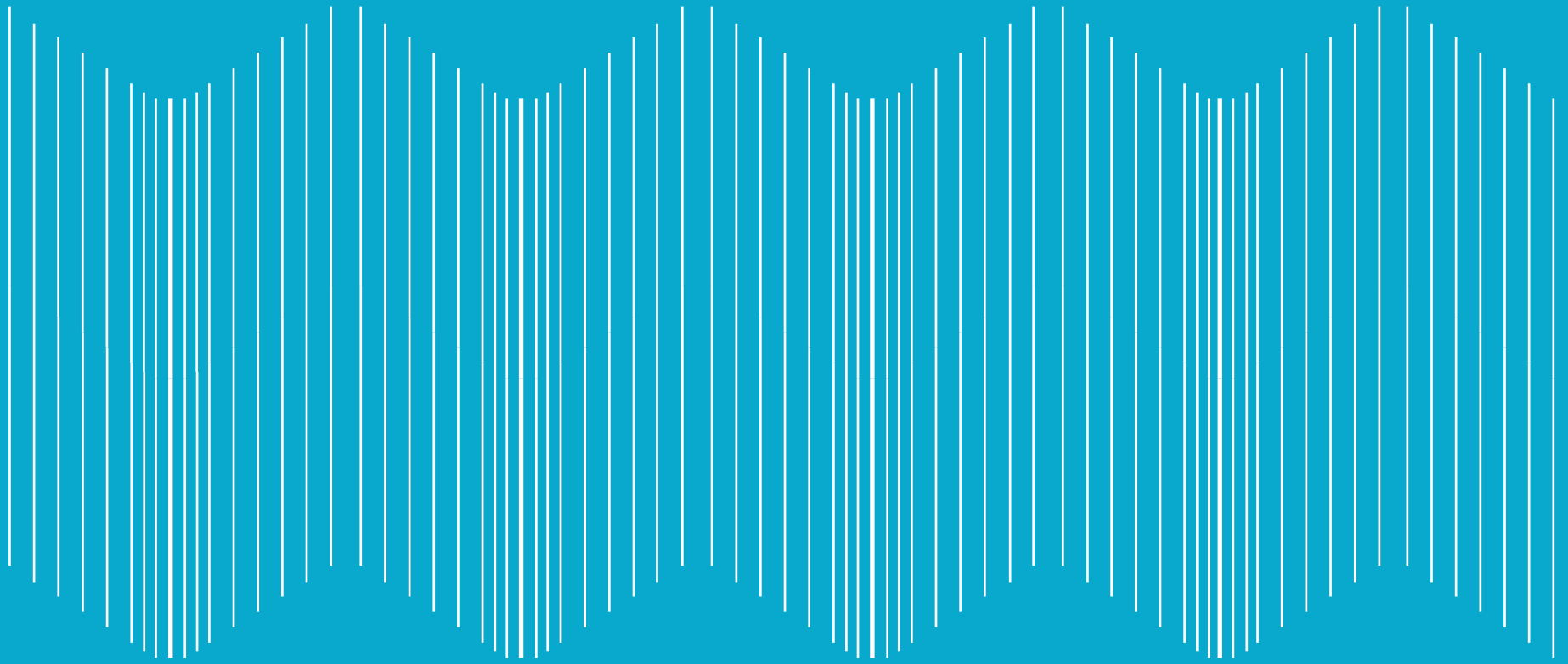
In 2013, Finland had the lowest healthy life expectancy for men among the reference group countries (57.3 years) and Germany the second lowest (57.8 years). The difference compared to Sweden (66.9 years), in particular, was significant, and high compared to the UK (64.4) and South Korea (64.9) as well. For women, healthy life expectancy was the lowest of the reference group countries in Finland in 2013 (56.2 years), and second-lowest in Germany (57.0). Sweden also had the highest healthy life expectancy for women (66.0 years).

Indicator 4.3. Healthy life years at birth, males (Eurostat).

Indicator 4.4. Healthy life years at birth, females (Eurostat).

In terms of life expectancy and healthy life expectancy, Finland still rates below the average in the reference group regarding citizens' health. Of the reference group countries, population health is the best in Sweden.

4 TECHNOLOGY BAROMETER STRUCTURE AND METHODS



4 TECHNOLOGY BAROMETER STRUCTURE AND METHODS

4.1. The structure of the Technology Barometer

The barometer indicators have been assembled under four thematic areas. These are *competence and knowledge production*, *knowledge society development*, *innovative society* and *sustainable development*. These are used in describing the typical features and development dimensions of a given modern society. These dimensions could be called the *information society*, *knowledge society*, *knowledge-value society*, and *sustainably developing society*. Many economies and countries have experienced these dimensions as a series of subsequent phases, but not in a straightforward manner, or linearly, due to the fact that any modern society contains several elements of the said dimensions at the same time, in each specific case. In addition, the various nations and economies are different in terms of their structural properties, dynamics and competence-intensiveness, and so are the development phases of their partial techno-economic systems. Development may result in a number of different directions, including the negative or what is understood as "regression". Among other things, the idea of evolving from an information society towards a society based on sustainable development entails the view of steering development in a desirable direction.

An information society is understood as a society where the central role is played by information production, processing, dissemination, and exploitation, in all societal sectors In a knowledge society it is essential to understand the opportunities made available by competence and ICT, in particular, including the capacity to apply them in practice, for both the private sector and society as a whole, in terms of functionality, efficiency, performance capacity and productivity. Instead of quantitative information, the decisive role is played by significant knowledge. According to Finland's reformed information society strategy for the years 2007–2014, technology has matured since the late 1990s. It now provides an applicable tool for wide societal change, but to this end requires renewal of existing structures and operating models alongside the adoption of new technologies. Knowledge has become an increasingly important central societal resource, one that can be exploited through technology with unprecedented effectiveness and efficiency. This means that the strategic focus has shifted from a society making good use of ICT to a growth oriented and knowledge-based society.

In a knowledge-value society, that is, an understanding-based society, knowledge has not only an instrumental but also an intrinsic value. In this domain, knowledge management and application are integrated with a moral outlook on the nature of the good life and its goals. A knowledge-value society places strong emphasis on the understanding and mastery of information and knowledge, on entrepreneurship and the capacity of the economy for regeneration, and on the intertwined and mutually supportive relationships between individuals, communities, and corporations of various sorts, and on internationality. As we see it, the most successful innovators are those who can exploit various expert sources with optimum efficiency in problem-solving situations and implement their objectives in close collaboration with other businesses, universities and research institutes.

The fourth dimension of societal development is called *a society based on sustainable development*. Sustainable development is a continual, controlled process of societal change that takes place on the global, regional and local scales towards securing adequate living conditions for the current and future generations. The sustainable development phase contains three pillars: social, economic, and environmental sustainability.

The Technology Barometer uses a framework of examination that enables structural comparisons in terms of the entire economy and individual industry sectors alike, regarding the intensiveness of innovation activities, for example, including other corresponding socioeconomic changes. Retaining the development dimensions in comparative examinations increases our understanding of various economies' and innovation systems' long-term changes and their dynamics. In addition, several current performance capacity comparisons are chiefly based on the investments made in innovation systems development, such as private and public R&D development investments, even if the most essential information from these investments pertains to their results and influence on the countries' performance capacity and well-being in the long term, for example the effects of information technology on the growth of productivity in the private and public sectors. Consequently, the structure and content of the Technology Barometer's indicators and survey findings emphasise the outcomes and effects of economic and innovation systems, in addition to their investment data.

4.2 How the survey was carried out

Alongside development of a society based on knowledge and competence, the barometer indicators may be used to identify the respective levels of background actors, organisations or the entire society in question. The questionnaire and some of the indicators describe the areas of interest of individual citizens, their values, while others describe the activities of organisations. Still others describe the state of society as a whole, and the ways and values of the various societies under examination. In this context, a value base refers to the value-related choices made by individuals, economic and political decision-makers, and society as a whole. Among other things, these are seen in citizens' health, income distribution, employment and equality between the sexes. In addition, value-related choices have an impact on environmental protection, and, ultimately, on the state of the environment as well. The value-related choices made, the appreciation enjoyed by various professions, and people's interest in science and technology as a profession or in the application of new knowledge in general, also exerts an influence on technology development, the economy and well-being. These questions are examined in the survey section of the Barometer.

The enquiry was divided into four parts in accordance with the partial indicators: *competence and knowledge production*, *knowledge society development*, *innovative society* and *sustainable development*. The first part sets out the respondent groups' assessments concerning techno-scientific skills and young people's interest in various professions. The second part of the enquiry, "Knowledge society development", covers the respondent groups' assessments of Finnish research activities, the prevailing state of technology development and various societal institutions. These have an impact on research and on societal development in general. The third part examines innovative societies. The level of investment, entrepreneurial activity and the impact of technology development on the quality of life are used as innovative society indicators. The fourth part of the survey sets out assessments of sustainable development focusing on environmental threats, the state of the environment, and action taken by the authorities.

The present publication is the outcome of the seventh Technology Barometer. The previous versions were published in 2004, 2005, 2007, 2010, 2012, and 2014. The Technology Barometer publications were all produced at an approximate interval of two years. To maintain comparability, we have continuously endeavoured to keep the instrument's basic structure unchanged. On the other hand, some of the content details have been updated so as to correspond with changes in the operating environment and the source materials. The survey material for this version was collected from May to September 2016.

The survey enquiry was addressed to four respondent groups deemed to be in key positions in terms of societal development: Members of the Academic Engineers and Architects of Finland TEK, young people, politicians and representatives of economic life. The first respondent group, TEK membership, consists of the organisation's elected union representatives and council and committee members. There were 52 responses from this group. The second respondent group is young people, for which a sample was gathered from six upper secondary schools located in different parts of Finland. These upper secondary schools were: Savonlinnan lyseon lukio, Eurajoen lukio, Nastolan lukio, Lahden yhteiskoulun lukio, Maunulan yhteiskoulun lukio (Helsinki), and Laurin lukio (Salo).

These schools are the same as in the previous survey. with the respondents being high-school (upper-secondary level) students and students sitting their matriculation examination. All of the respondents forming this sample responded to the questions. There was a total of 325 responses from the young people group. Due to the annual grade rotation, the persons who responded were not the same as those who responded during the previous survey rounds of the Technology Barometer. The third group is politicians, the fundamental set of which consists of Members of Parliament, members of Regional Councils, and town council members from the seven largest Finnish cities. Of this group, 42 people responded to the survey. The fourth group of respondents is representatives of business life. The fundamental set forming this group consists of the hundred largest companies in Finland, measured by product development investments. Company executives responsible for their companies' development and innovation activities formed the respondent group for the survey enquiry. A sample of 30 companies was obtained from these.

The various respondent groups were allocated their own specific series of questions. Due to the abundance of this material, we shall concentrate here on presenting the differences of opinion between the respondent groups, and any changes that have occurred compared to the results of the previous Technology Barometer survey. The figures present the average response of the respondent groups.

4.3 The indicator-based study

The four modules of the Technology Barometer

Statistics and other information sources offer indicators that help in describing the state of society and its development. In being groups together under the banner of these developmental dimensions, the indicators and combinations of indicators used in the Technology Barometers provide an opportunity to examine and compare techno-economic and socioeconomic changes and dynamics across different countries. The Technology Barometer uses four modules, or partial entities, each containing three indicator clusters as shown in Figure 7.

Figure 7. The contents of the Technology Barometer.

Figure 7 is largely based on what we call *an information society*, in other words the dimension describes the investment in competence and skills by a given society. The indicators describing this dimension include general investment in education and training, the level of basic education, schooling and general education, as well as the level of investment in research and product development.

A knowledge society is a dimension depicted by indicators relating to techno-scientific competence, the use of ICT, the understanding and management of knowledge, and application of new knowledge. Instead of development investment in general, the Technology Barometer uses the allocation of investment to the development of techno-scientific skill and skills, making good use of ICT, and the results achieved through these investments in order to measure how effectively an information society transforms into a knowledge society.

A knowledge-value society is the name we give to this dimension, and it is depicted by indicators based on the capacity to apply new knowledge, entrepreneurship, networking and openness to international activities. Sustainable development is described by indicators relating to the well-being of the environment and its management, including data items which give a versatile picture of the cohesion between society and the population, such as income distribution, equality between sexes, and employment.

So all in all, the Technology Barometer indicators measure a great many of the factors that shape a society's character and development. In doing so the Barometer provides an overall picture of the level of development in the various countries being compared. This development is demonstrated using four indicator clusters *(information society, knowledge society, knowledge-value society, a sustainably developing society*) that describe the society's current level of development. The indicators describe the target countries' mutual placing and its potential changes with the aid of available statistical data and other available, relevant research-based data, among other corresponding information.

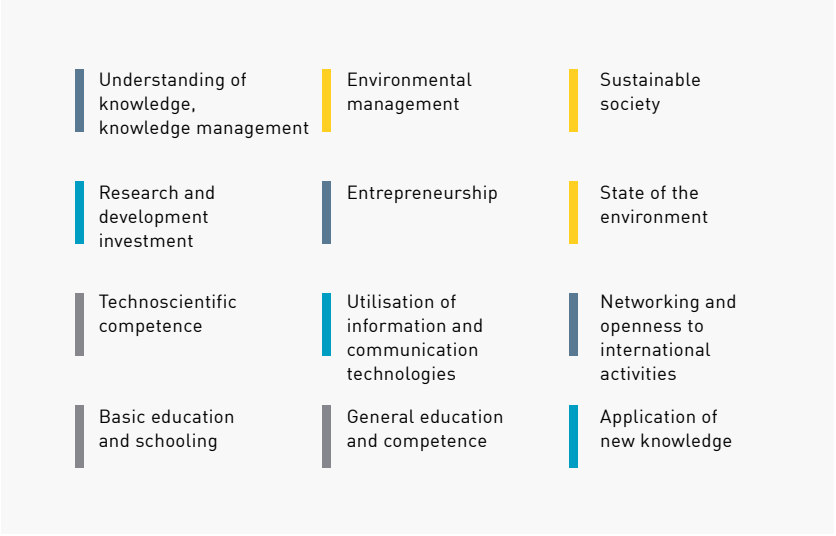


FIGURE 7.
The contents of the Technology Barometer.

In short

- The Technology Barometer measures information society development with the aid of young peoples' reading literacy skills, mathematical and scientific skills (PISA surveys) and in terms of investment in education, research and development (Figure 7, grey area).
- The indicators describing a knowledge society measure investment in research and development, the use of information and communications technology, and the contributions of small and medium-sized enterprises (SMEs) to innovation and innovation cooperation. (Figure 7, light blue area).
- The indicators describing a knowledge-value society relate to patenting, the share of scientific publications, entrepreneurial activeness, the share of nascent companies, risk capital investment, investments made by the private sector, incoming direct foreign investment and the share of foreign trade as a proportion of GDP (Figure 7, blue area).
- The indicators describing a society based on sustainable development relate to the state of the environment, environmental management, wide-scoped social cohesion and the population's value base that are depicted by the indicators of income division, equality between the sexes and employment, among others (Figure 7, yellow area).

The choice of indicators, the calculation method, and reliability of results

For the statistical indicators, data was collected from Finland and eight other countries: Sweden, Denmark, the Netherlands, the United Kingdom, Germany, Japan, South Korea, and the United States. The main source of material was Eurostat, the Statistics Office for the European Union. The most recent available internationally comparable statistical data is collected for each partial indicator involved. In some countries, such as Japan, the accumulation of this data may be considerably slower compared to the others. This influences the choice of specific years for the comparison.

In Tekbaro 2017, about a quarter of the most recent data is from 2015, one-third from 2014, a quarter from 2013, and the remainder from previous years. As a rule, the behaviour of the countries' proportional ratings is fairly stable in the said statistical indexes. Naturally, it is a completely different issue whether these ratings can adequately describe all of the components that should be taken into account in the changed situation. It is a matter of choosing the indicators. The structure of an economy is described by macro-economic indicators, such as the share of educational expenditure, research and development costs, ICT costs, fixed investment, high technology production and exports, direct investment, foreign trade, energy consumption and environmental protection costs of GDP; these are fairly comprehensively included in the analysis. In addition, there are components relating to the population and private households, such as the rate of employment or unemployment, the share of new entrepreneurs, that of people with higher education, the number of scientific publications per thousand citizens and the prevalence of broadband communication connections, or components relating to business activity, such as the share of nascent companies and that of companies engaged in innovative activities and e-commerce companies.

Before calculating the combined indicators, the annual scores of each partial indicator are standardised within the reference group in question. The average value of the standardised figures is zero. A negative score of a country means that the country's achievements are below average. If the score is positive, the country's achievements are better than average. The value of a combined index consists of the arithmetic average value of the standardised scores of these partial indicators. Some liberties have been taken in calculating the combined indicators in that if there was no rating for a specific partial indicator for a specific year, the figures for another year were used. The standardised score can be interpreted as an index depicting the proportional ranking of the country.

Thus, the combined indicators describe the countries' proportional ratings compared to the reference group. In this index system, Finland's rating depends on:

1. The country group. When assessing the changes, it is important that the country group remains unaltered, in other words the data must be derived from the same countries as previously. It can occasionally happen that the country group is of minor importance.
2. Country-specific data and their modifications which affect their mutual comparability. Their assessment is somewhat problematic, however. Usually, the data obtained from the same source is assumed to be comparable.
3. The indicator basket, or the selection of indicators for the calculations. All of the indicators applied, including those which "describe the same things", must have identical weightings. This means that the weighting structure of the indexes will remain unchanged.

When assessing the results, it should be observed that even if all the indicators show that Finland's development is positive, that of the other countries involved may be

better, causing a lower proportional rating for Finland. This means that the index result often indicates how slowly or quickly Finland is progressing compared to the reference group countries. A rapid leap by an individual country may occasionally overshadow the favourable progress of all the others. In that case, the assumption is that the leap is not a measurement error. Potential measurement errors raise questions about the Technology Barometer results' statistical reliability and their sensitivity to erroneous interpretations. Erroneous or unreliable observations are often detected by comparing the time series of individual indicators between the various countries involved. Unfortunately, the Technology Barometer cannot offer a comprehensive or content-wise changeless time series covering all the data items used. Instead, what is available consists of individual measurement results. Indicators of this type include the following: PISA surveys, GEM assessments, several indicators depicting the state of the environment, plus several other statistical data items acquired from outside the Eurostat (OECD, UN, etc.).

As in earlier editions, the usability and availability of the indicators was assessed for Tekbaro 2017. Some of the partial indicators have been omitted or replaced, either due to them not being available with identical content or the indicator in question having been found to be obsolete. Moreover, the changed industry classification may have led to some of the indicators no longer being available from the data sources used. In addition, some of the previously used time series may have changed retrospectively or as of a specific year. Also, in some instances the figures used might be tentative.

Tekbaro2017 combines the sub-areas previously used to describe sustainable development, namely air quality and biological diversity, into a single new area, the state of the environment. The reason for this is that indicator values for biological diversity have not been updated for several years. To get around this problem, as new indicators we chose the amount of volatile organic compound emissions as a proportion of GDP, the risks posed to human health by airborne and water-borne impurities, exposure to microscopic particles in the air and the consequent risks, the proportion of the population that are exposed to microscopic particles above the risk level set by the World Health Organisation, the amount of protected terrestrial and/or marine areas in the country, and protection of the habitats of different animal species. We have also added some new indicators to the knowledge comprehension and management sub-field. These are the proportion of industrial exports made up of high-technology exports, the proportion of service exports accounted for by information and telecommunication technology (ICT) understood both narrowly and more broadly. In the Basic education and schooling sub-area, we have complemented the PISA measures with a measure of the student/teacher ratio in both primary- and secondary-level education. Also, calculation of some indicators has been modified or simplified. This includes indicators that are not available as such in proportion to the population or GDP.

Since the indicators chosen or their time series have often changed from the figures used in the previous Technology Barometer, the results of the previous round were also recalculated with the new indicators or new time series. The results of this round and the recalculated results of the previous round are described in Chapter 2. In interpreting the combined indicators, the reader should note the narrow information base or complete lack of information from certain countries. For instance, for the United States scientific-technological competence consists of only three indicators: the proportion of the labour force that have received a higher-level education, new higher degrees in science and technology fields, and the proportion of doctoral degrees in the same fields. And there was no data available for indicator application of new knowledge from the US, South Korea, or Japan, because this sub-region relies mostly on statistical data collected by Eurostat. In this case, the application of new knowledge is allocated the average of the reference group, i.e. zero. This should not be interpreted as a ranking of these countries on their relative skill or success in the application of new knowledge. Such data limitations have been mentioned in connection with the figures in question.

Table 2. Contents of the Technology Barometer by subject area

INFORMATION	Basic education and schooling	Young people's reading literacy Young people's mathematical skills Young people's skills in the natural sciences The student/teacher ratio in primary-level education. The student/teacher ratio in secondary-level education.
	All-round education and skills	Share of educational expenditure of GDP (%) Participation in lifelong learning (% of people aged 25–64) People with higher education (% of people aged 25–64)
	Scientific-technological and skills	Percentage of employed people with a third-level degree New degrees in science and technology fields, higher education (‰ of people aged 20–29) Doctoral degrees in science and technology fields (% of people aged 25–34) Proportion of R&D personnel (% of the labour force) Proportion of female scientists (%) Labour force employed by high and medium-high technology (% of the total labour force) Labour force employed by high technology industry and services (% of the total labour force)
KNOWLEDGE	Investment in R&D	Share of companies' R&D expenditure of GDP (%) Share of public R&D expenditure of GDP (%) Share of public funding of R&D expenditure (%)
	Information technology and communications technologies	Share of information technology expenditure of GDP (%) Share of communication technology expenditure of GDP (%) Prevalence of fixed broadband among the total population (%) Internet use in the total population (%), Eurostat Internet use in the total population (%) Private households with broadband connections (% of households) Prevalence of mobile phones among the total population, subscriptions per 100 inhabitants Prevalence of mobile broadband among the total population (%) Prevalence of fixed broadband, at least 10 Mbps, among the total population (%) Prevalence of fixed broadband, at least 100 Mbps, among the total population (%) Share of internet users who have made online purchases of the population (%) Prevalence of broadband connections in the whole population (%) Share of companies making online purchases (% of the total number of companies, excluding micro-sized enterprises and financing services) Share of online sales of companies' turnover (%, excluding micro-sized enterprises and financing services) Secure internet servers per million inhabitants
	Application of new knowledge	Share of innovative SMEs that have received public R&D funding (%) Share of medium-sized companies engaged in innovative activities (% of all companies) Share of small companies engaged in innovative activities (% of all companies) Share of small companies that have brought innovation new products to market (%) Share of medium-sized companies that have brought innovation new products to market (%) Amount of innovation cooperation done by small companies involved in innovation activity (%) Amount of innovation cooperation done by medium-size companies involved in innovation activity (%)

KNOWLEDGE	Comprehension and management of information	Patent Cooperation Treaty (PCT) patent applications, per million residents Patent applications submitted to EPO, per million inhabitants Patents granted by USPTO, per million inhabitants. Number of scientific articles published, per thousand inhabitants. Labour productivity (GDP per working hour) Production value of high technology fields, share of GDP (%) Added value produced by high and medium-high technology fields, share of GDP (%) High technology exports, share of total exports (%) Market-driven competence-intensive services, share of GDP (%) High technology exports as a proportion of total exports (%) Information and telecommunication technology (ICT) as a proportion of service exports (%) Information and telecommunication technology (ICT) as a proportion of service exports (%)
	Entrepreneurship	Entrepreneurial activeness, among the adult population (%) Share of informal investors among the adult population (%) Share of new companies among all active companies (%) Rate of investment by the private sector (%) The number of work stages needed to register a new business
	Networking and internationality	Share of inbound and outbound direct foreign investments of GDP (%) Share of outbound direct foreign investments as a proportion of GDP (%) Share of inbound direct foreign investments as a proportion of GDP (%) Share of foreign funding of company R&D expenditure as a proportion of GDP (%) Openness to international trade, value of imports and exports of goods, share of GDP (%) Openness to international trade, value of imports and exports of services, share of GDP (%)

SUSTAINABLE DEVELOPMENT		
	Health	Life expectancy in years, males Life expectancy in years, females Healthy life expectancy, males Healthy life expectancy, females
	Income distribution	Ratio of income distribution, unevenness of income distribution Poverty risk prior to social income redistribution (%) Poverty risk after social income redistribution (%)
	Employment	Employment rate (% 20–64 age group) Employment rate of ageing people (% of people aged 55–64) Unemployment rate (%) Youth unemployment as a proportion of total unemployment (%) Share of long-term unemployed (%) Earned income tax rate (%)
	Equality between the sexes	Share of female Members of Parliament (%) Share of female government ministers (%) Women's employment rate (%) Gender-based difference in earned income (% of men's average hourly earnings)
	Environmental protection	Investment in environmental protection, euro per capita Investment in environmental protection as a proportion of GDP (%) Volume of greenhouse gas emissions per capita Amount of greenhouse gas emissions as a proportion of GDP Energy-intensity, total energy consumption as a proportion of GDP. Share of renewable energy sources of the total energy production (%)
	State of the environment	Amount of sulphur oxide emissions as a proportion of GDP Amount of nitrogen oxide emissions as a proportion of GDP Volume of volatile organic compound emissions in proportion to GDP Threats posed to human health by airborne and waterborne impurities The proportion of the population exposed to microscopic particles above the safe limit determined by the WHO (%) Protected terrestrial areas (%) Protected marine areas (%) Protection of the habitats of different animal species (%).

5 References:

Aagaard, K. 2011. Kampen om basismidlerne, PhD thesis, Aarhus University, Denmark.

Education at a Glance 2016: OECD Indicators. [referred to: 7 December 2016]. Link: http://www.oecd-ilibrary.org/docserver/download/9616041e.pdf

Global Innovation Index 2016. [referred to: 5 October 2016]. Link: https://www. globalinnovationindex.org/gii-2016-report

Honkatutkia, J., Tamminen, S., Ahokas, J. 2014. Suomi on jo palvelutalous (Finland is already a service economy), VATT Institute for Economic Research Policy Brief 1-2014.

Hämäläinen U., Juutilainen V-P. 2010. Nuoret – duunissa vai MOLlissa?, Talous & Yhteiskunta 1/2010.

Hämäläinen U., Tuomala J. 2013. Faktaa nuorisotyöttömyydestä (Facts on youth unemployment), VATT Policy brief 2-2013.; Larja L., Nuorten elinoloja ei voi kuvata pelkän työttömyysasteen avulla, Hyvinvointikatsaus 1/2013.

Industrial Development Report, 2016. The Role of Technology and Innovation in Inclusive and Sustainable Industrial Development, UNIDO 2016.

Kauhanen A., 2012. Saksan työttömyysihme, Ajankohtaista taloudessa ja tutkimuksessa 1/2012, Elinkeinoelämän tutkimuslaitos.

Lukkari, Jukka, 2015. Kehitystyön alamäki jatkuu. Tekniikka ja talous 12.6.2015.

Hämäläinen U., Tuomala J. 2015. Rakenteellisen työttömyyden riski kasvaa (The risk of structural unemployment is growing), VATT Institute for Economic Research Policy Brief 2-2015.

(Ministry of Education and Culture, 2016). PISA 2015: Suomalaisnuoret edelleen huipulla, pudotuksesta huolimatta (Finnish youth still at the top, despite the drop) [referred to: 7 December 2016]. Link: http://www.minedu.fi/OPM/Tiedotteet/2016/12/ PISA2015.html

Schmöller M. 2013. Näkökulma Saksan "työllisyysihmeeseen": työmarkkinatoteutumat ja hyvinvointi työmarkkinoiden muutoksen jälkeen (An outlook on Germany's "employment miracle": labour market realisation and well-being after the labour market changes), Bank of Finland, Department of Monetary Policy and Research, BoF Online 9/2013.

Skedinger P, 2016. Työmarkkinat Suomessa ja Ruotsissa – ruotsalainen näkökulma (The labour markets in Finland and Sweden: A Swedish Perspective), Talous ja yhteiskunta 2/2016.

Statistics Finland, 2015a Official Statistics of Finland (OSF): Research and development activities [online publication]. ISSN=1798-6206. 2014, Yritysten tutkimus- ja kehittämistoiminta (Company research and development activities). Helsinki: Statistics 5 October 2016]. Link: http://www.stat.fi/til/tkke/2014/tkke_2014_2015-10-29_kat_001_fi.html

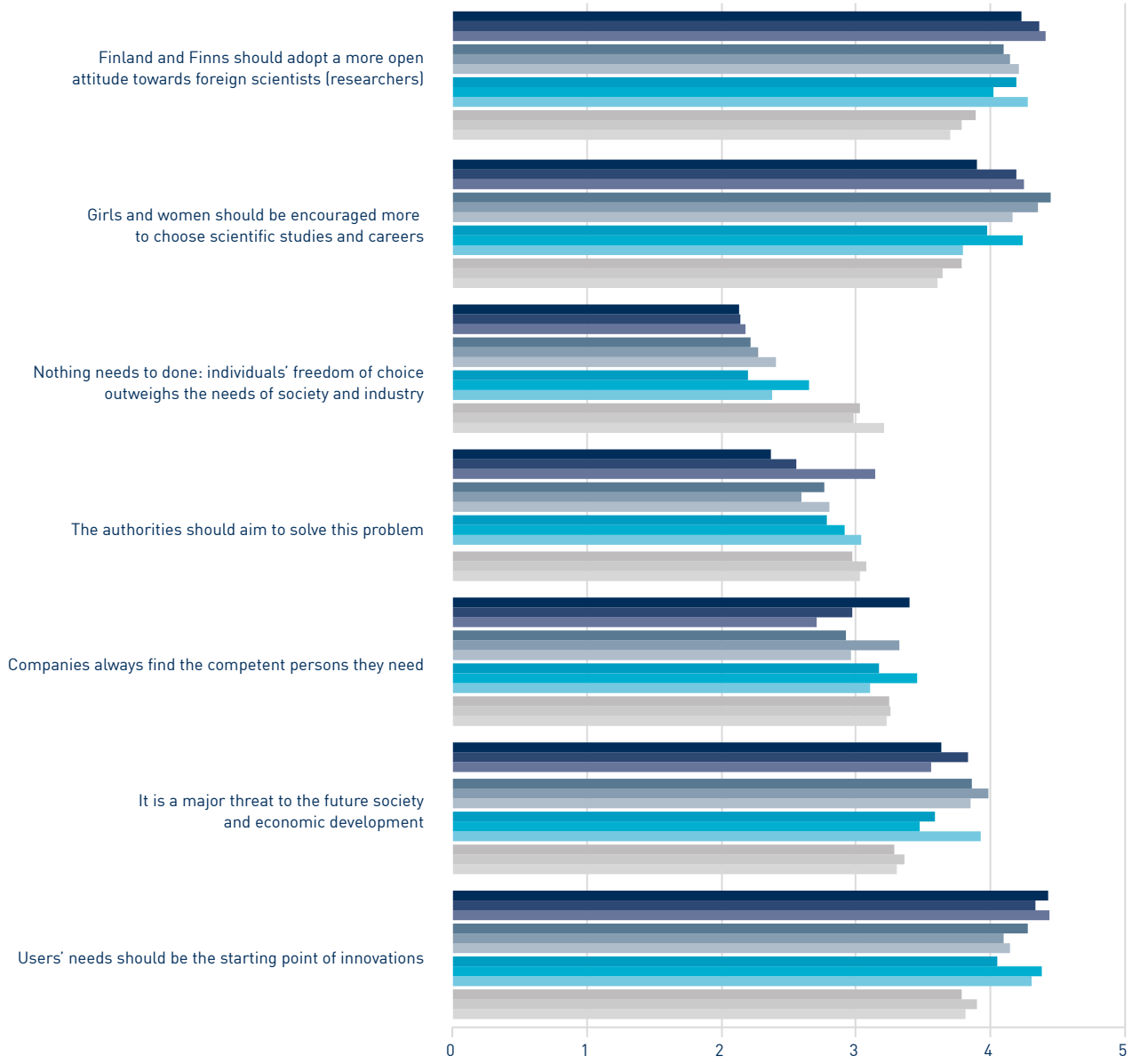
Statistics Finland, 2015b Official Statistics of Finland (OSF): Research and development activities [online publication]. ISSN=1798-6206. 2014, Yritysten tutkimus- ja kehittämistoiminta (Company research and development activities). Helsinki: Statistics 5 October 2016]. Link: http://www.stat.fi/til/tkke/2014/tkke_2014_2015-10-29_kat_002_fi.html

Office of the Council of State, 2015. A Finland of Solutions. The strategic programme of the government of Prime Minister Juha Sipilä. 29 May 2015.

Industrial Development Report, 2016. The Role of Technology and Innovation in Inclusive and Sustainable Industrial Development, UNIDO 2016.

APPENDIX 1. QUESTIONNAIRE

Competence and creation of knowledge

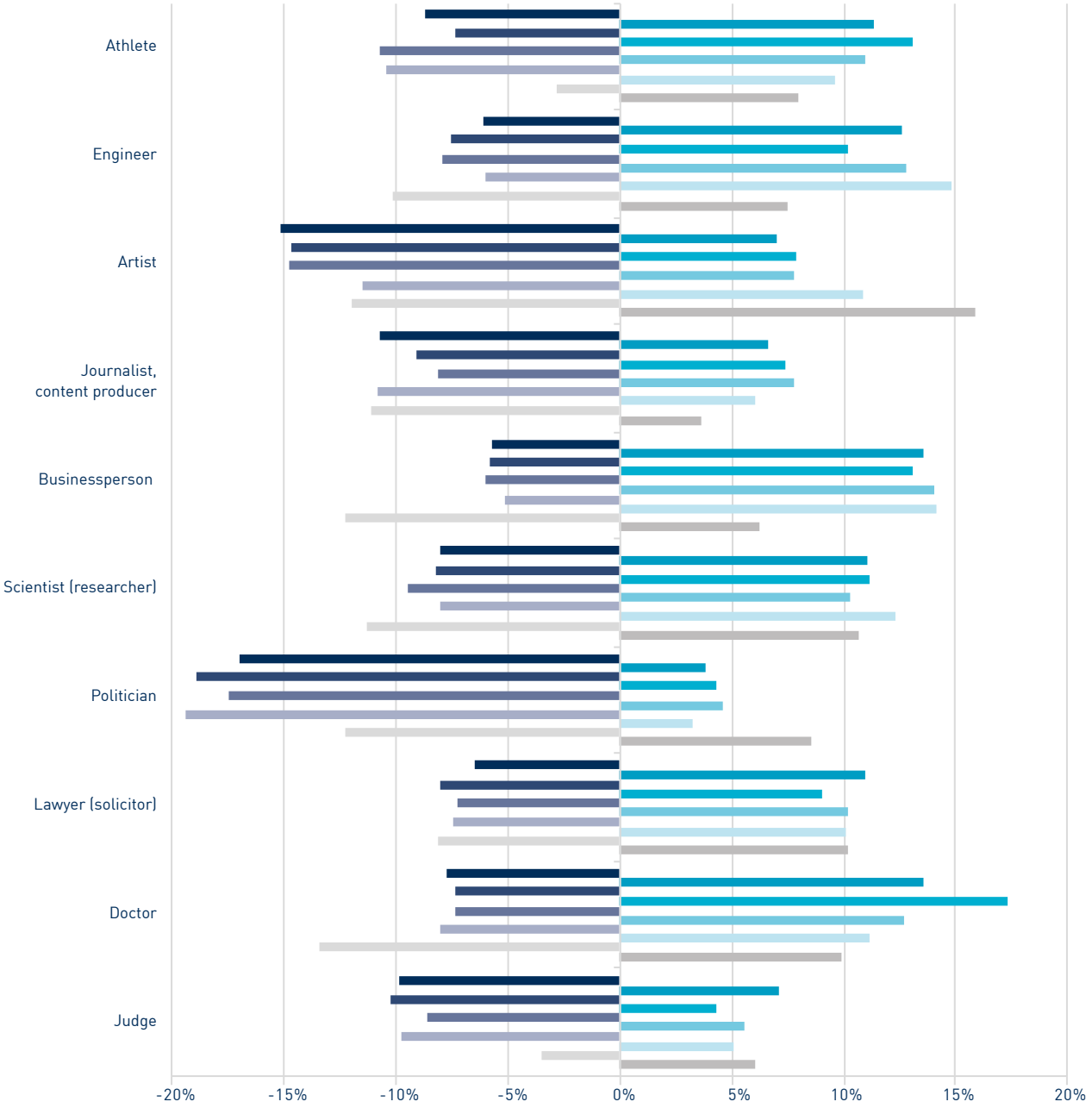


SURVEY GRAPH 1.1

Assessments of young people's interest in science and technology.

(Question presented: Do you agree or disagree with the following statements when saying that young people are less interested in science and technology?

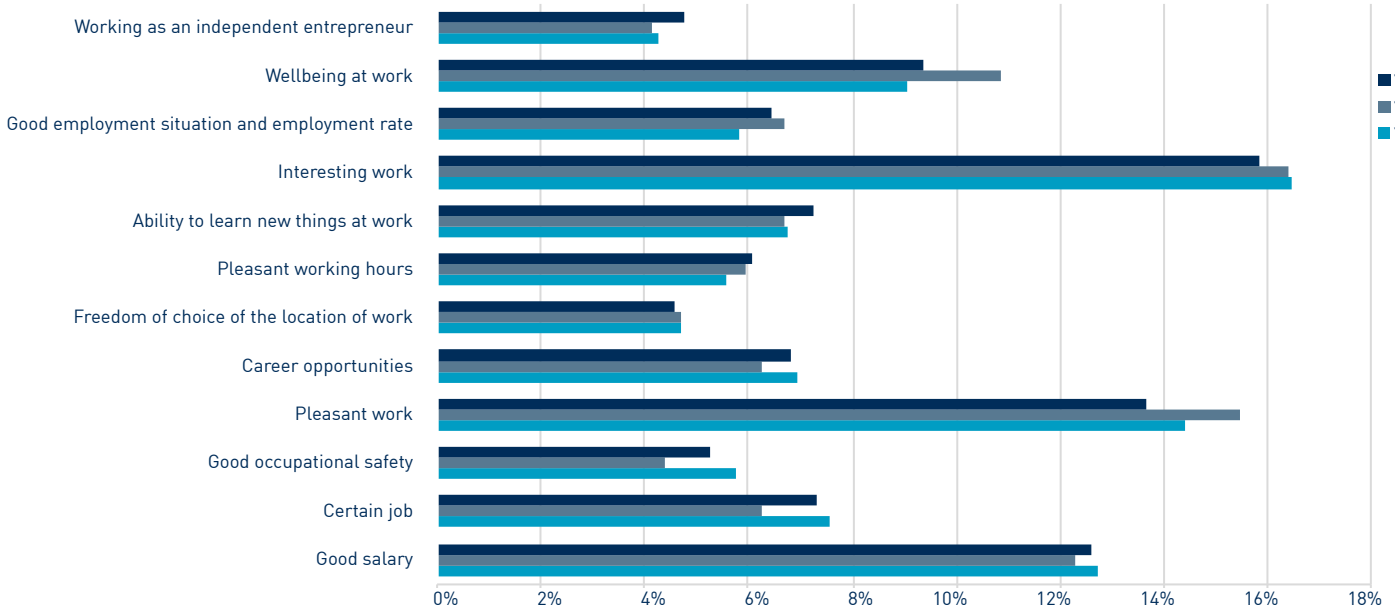
1 = Fully disagree,
2 = Somewhat disagree,
3 = Difficult to say,
4 = Somewhat agree,
5 = Fully agree).



SURVEY GRAPH 1.2

Interest in different professional groups. The respondent group is Young People. The percentage shares describe the proportion of responses of the total responses to the survey.

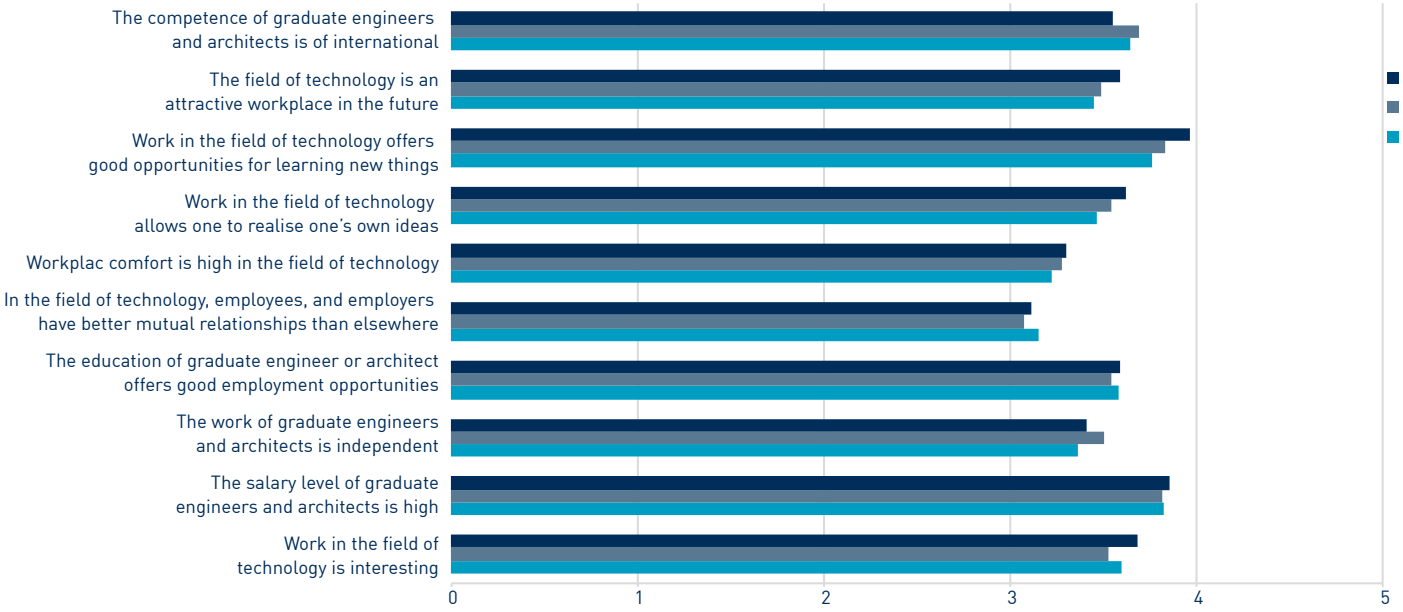
(Question presented: Several professions and work tasks are listed below. Which of these fields are ones in which you would prefer to work? Choose two to four fields. And which fields interest you the least?).



SURVEY GRAPH 1.3

Reasons influencing the choice of professional field among young people.

(Question presented: Why did you choose these as the most preferable fields? The question was answered by giving 2 points to the most important reason and 1 point to the second-most important one. The figure presents the total scores).



SURVEY GRAPH 1.4

Young People's views on the field of technology and engineering work.

(Question presented: Below you will find a list of statements on working in the field of technology and typical features of engineering work. What is your opinion on each of the following statements?

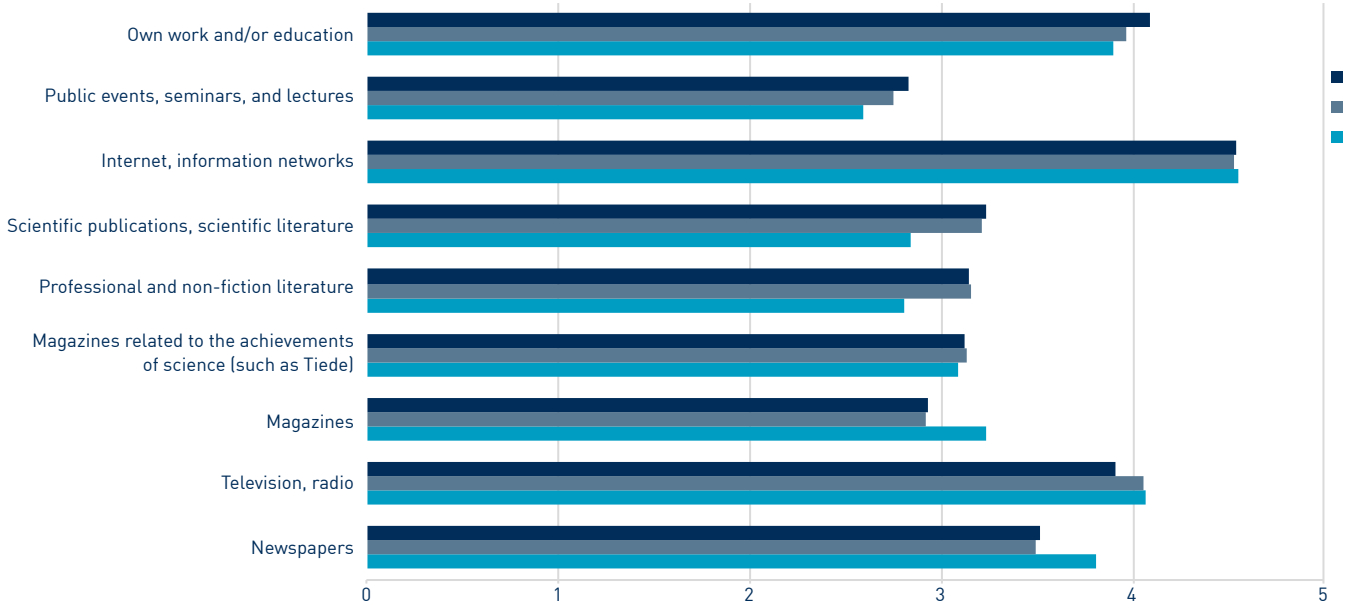
5 = Fully agree,
4 = Somewhat agree,
3 = Difficult to say,
2 = Somewhat disagree,
1 = Fully disagree).

SURVEY GRAPH 1.5

Young People's interest towards various societal issues.

(Question presented: The following is a list of issues which may interest people. How interested are you personally in these issues? Interest may consist of following the news, TV and radio programmes and articles on a particular theme, for example.

5 = Very interested,
4 = Fairly interested,
3 = Difficult to say,
2 = Fairly little interest,
1 = Very little interest.

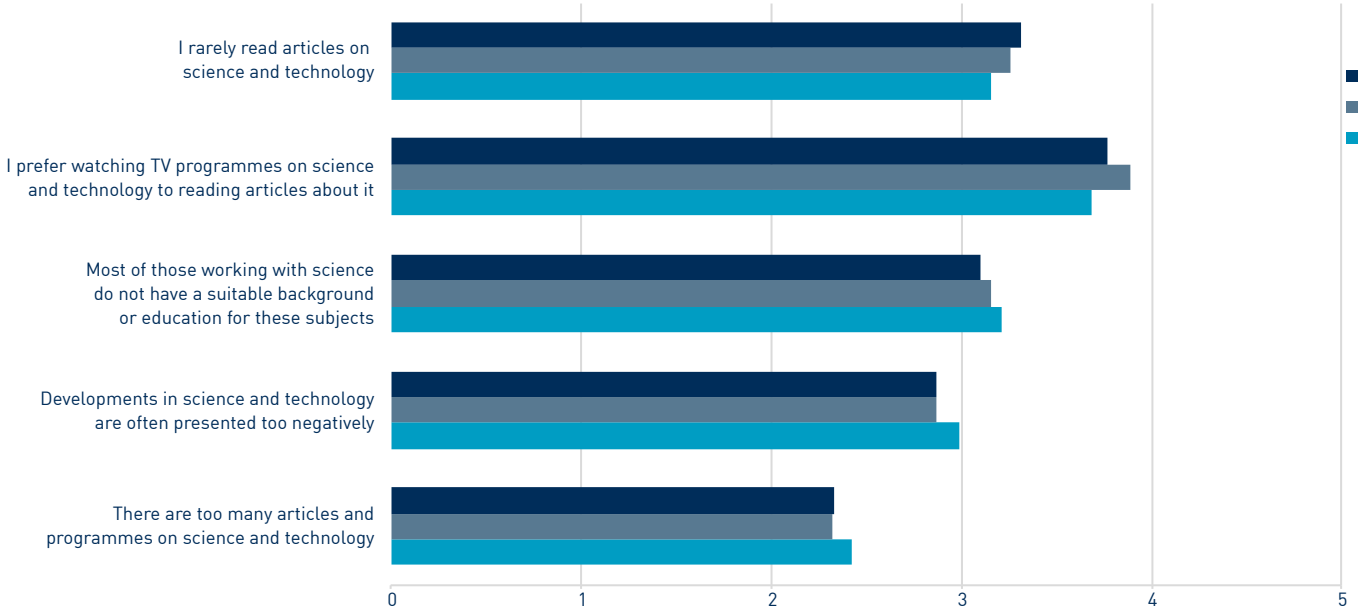


SURVEY GRAPH 1.6

Young People's assessments on monitoring the progress of science and technology with the aid of various sources of information.

(Question presented: The following is a list of some information sources for monitoring the progress of scientific and technological development. How important are they to you personally as conveyors of scientific and researchrelated knowledge?

5 = Very important,
4 = Fairly important,
3 = Difficult to say,
2 = Fairly unimportant,
1 = Very unimportant).



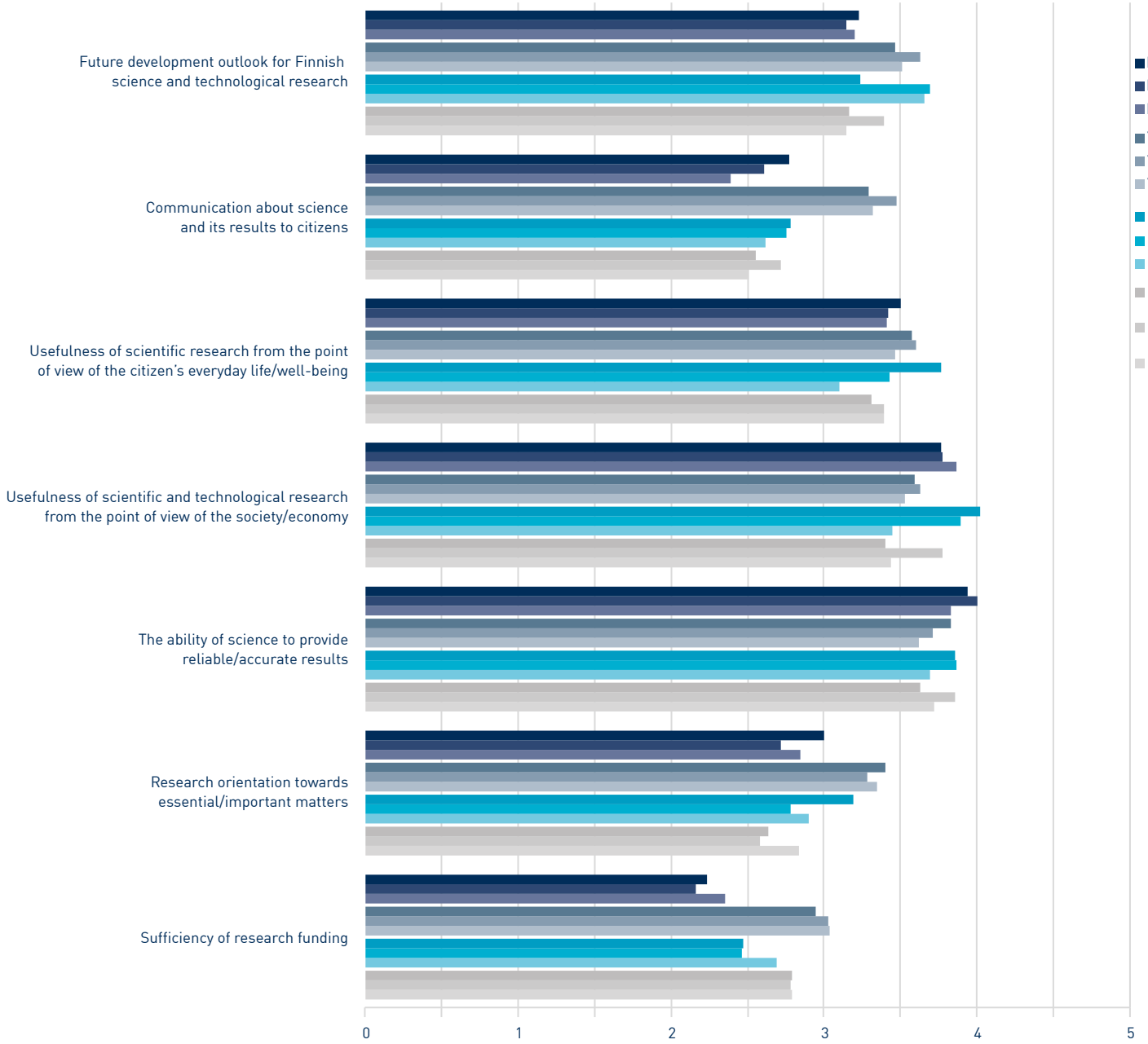
SURVEY GRAPH 1.7

Young People's assessments on news provision concerning science and technology.

(Question presented: Tell us whether you agree or disagree with the following statements on news provision in the media on science and technology.

5 = Fully agree,
4 = Somewhat agree,
3 = Difficult to say,
2 = Somewhat disagree,
1 = Fully disagree).

KNOWLEDGE SOCIETY DEVELOPMENT

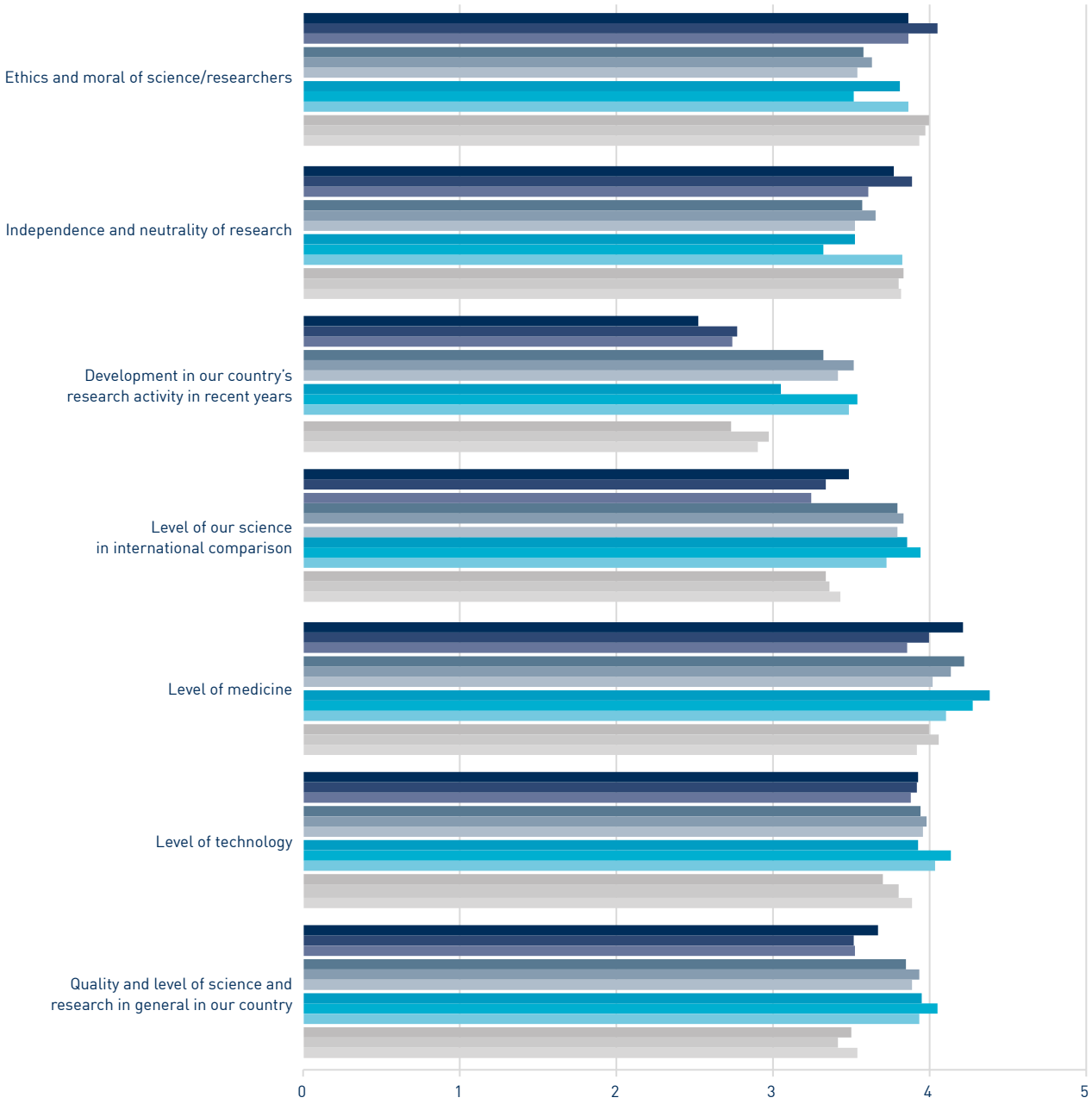


SURVEY GRAPH 2.1

Assessment of Finnish science and research, Part 1.

(Question presented: How do you see the following matters related to science and to technical research in Finland nowadays? Do you feel that the situation is good or bad?

1 = Very bad,
2 = Fairly bad,
3 = Difficult to say,
4 = Fairly good,
5 = Very good).

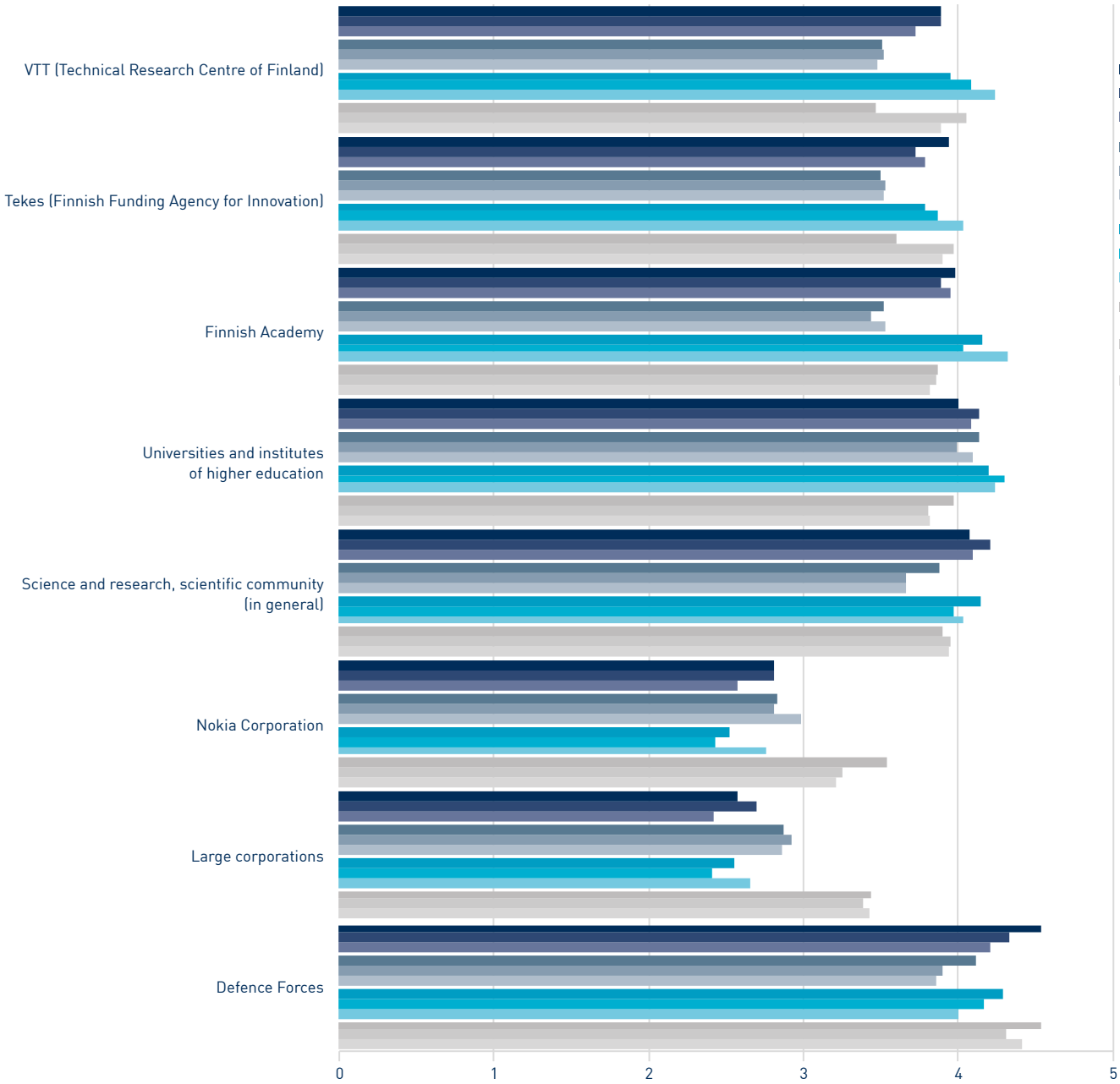


SURVEY GRAPH 2.2

Assessment of Finnish scienc e and r esearch, Part 2.

(Question presented: How do you see the following matters related to science and to technical research in Finland no wadays? Do you feel that the situation is good or bad?

1 = V ery bad,
2 = Fairly bad,
3 = Difficult to say,
4 = Fairly good,
5 = Very good).

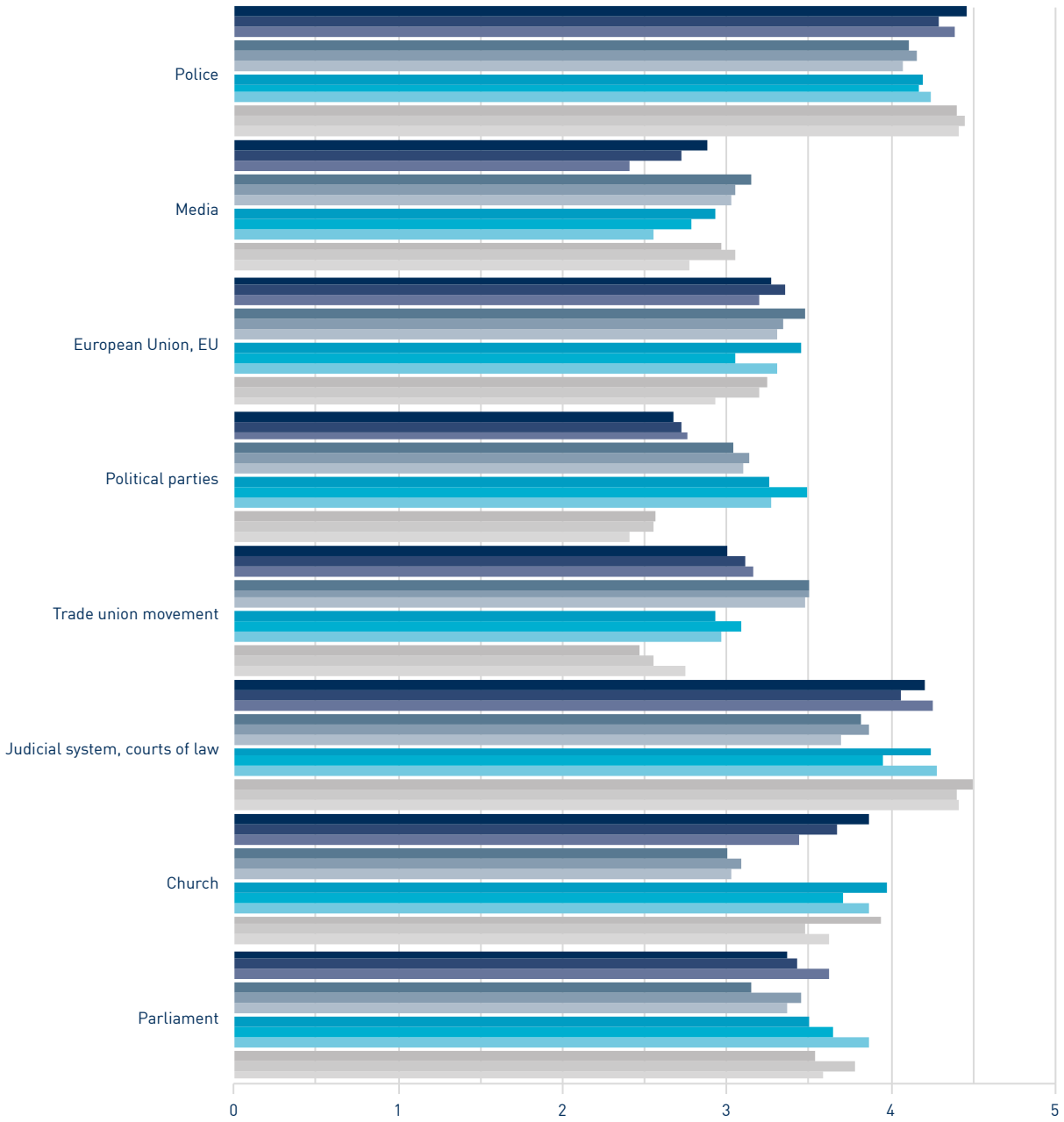


SURVEY GRAPH 2.3

Trust induced by institutions, Part 1.

(Question presented: How much trust do you have in the the functioning of the societal institutions listed below being aimed at the public good, fair and equal with respect to theirs takeholders, and ethically sustainable?

1 = Very little,
2 = Fairly little,
3 = Difficult to say,
4 = Fairly much,
5 = Very much).

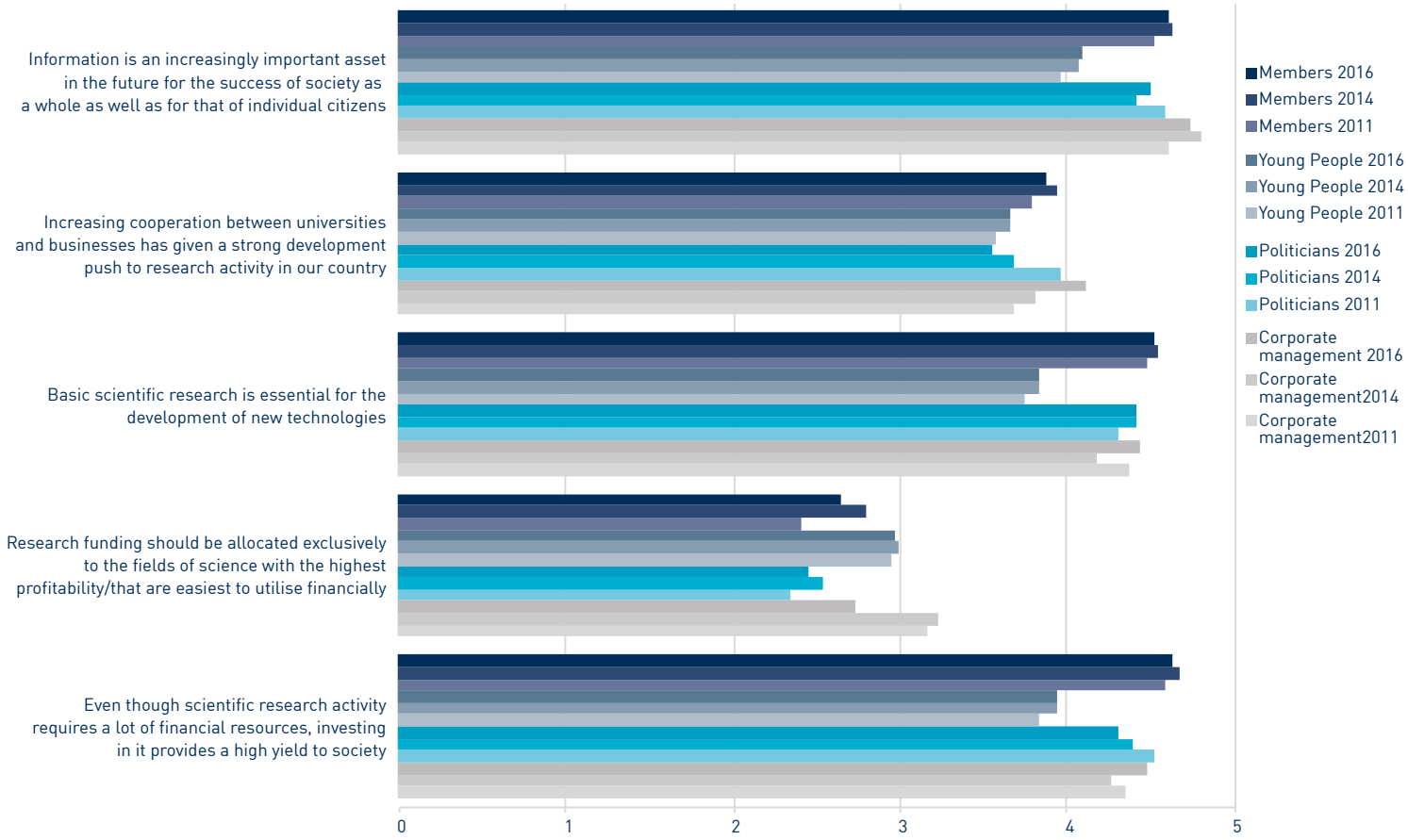


SURVEY GRAPH 2.4

Trust induced by ins titutions, Part 2.

(Question presented: How much trust do you have in the the functioning of the societal institutions listed below being aimed at the public good, fair and equal with respect to their stakeholders, and ethically sustainable?

1 = Very little,
2 = Fairly little,
3 = Difficult to say,
4 = Fairly much,
5 = Very much).

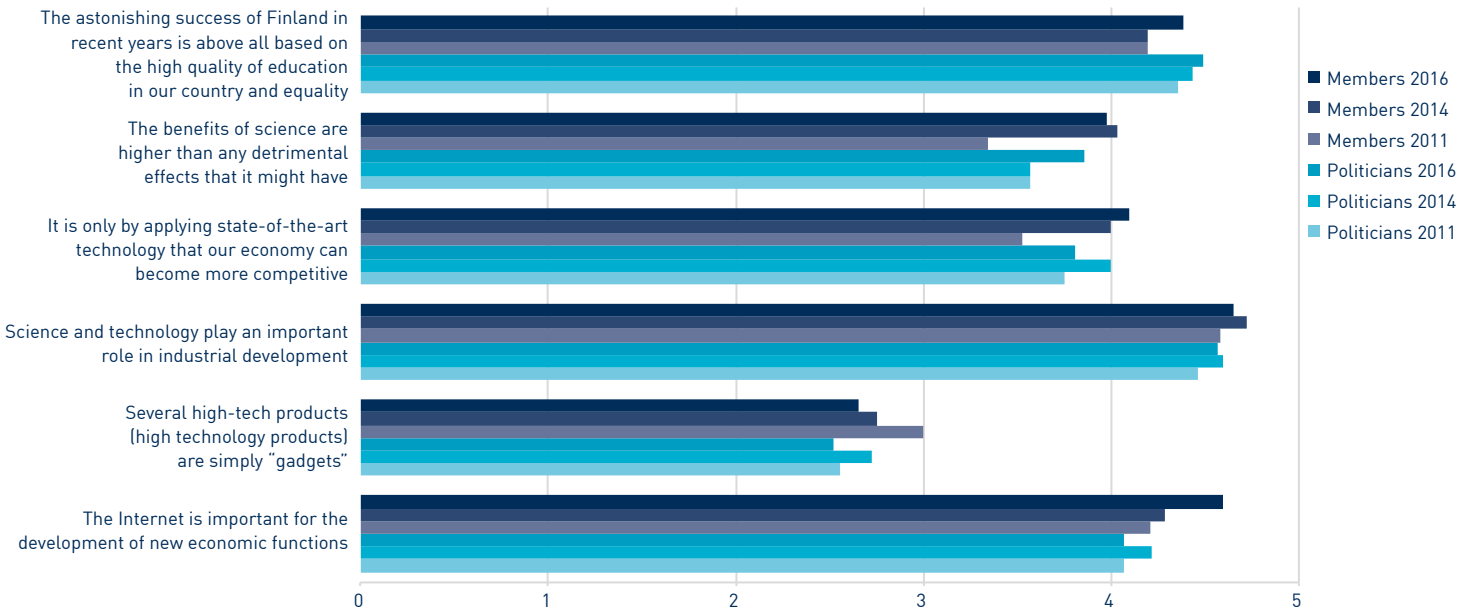


SURVEY GRAPH 2.5

Significance of research from the viewpoint of economic and societal development.

(Question presented: What is your opinion regarding the following statements concerning the use of results from scientific and technological research? Do you agree or disagree?

1 = Fully disagree,
2 = Somewhat disagree,
3 = Difficult to say,
4 = Somewhat agree,
5 = Fully agree).

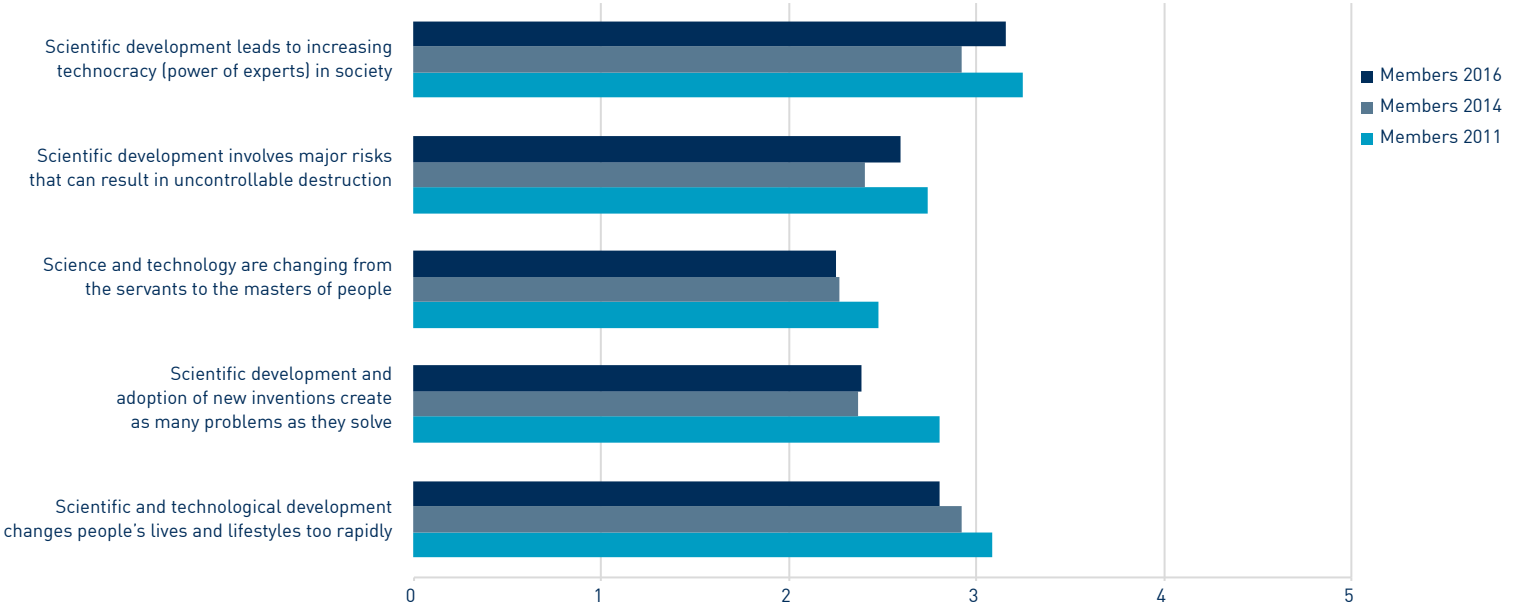


SURVEY GRAPH 2.6

Status of technology in today's Finland.

(Question presented: What is your view regarding the following statements? Do you agree or disagree?

1 = Fully disagree,
2 = Somewhat disagree,
3 = Difficult to say,
4 = Somewhat agree,
5 = Fully agree).

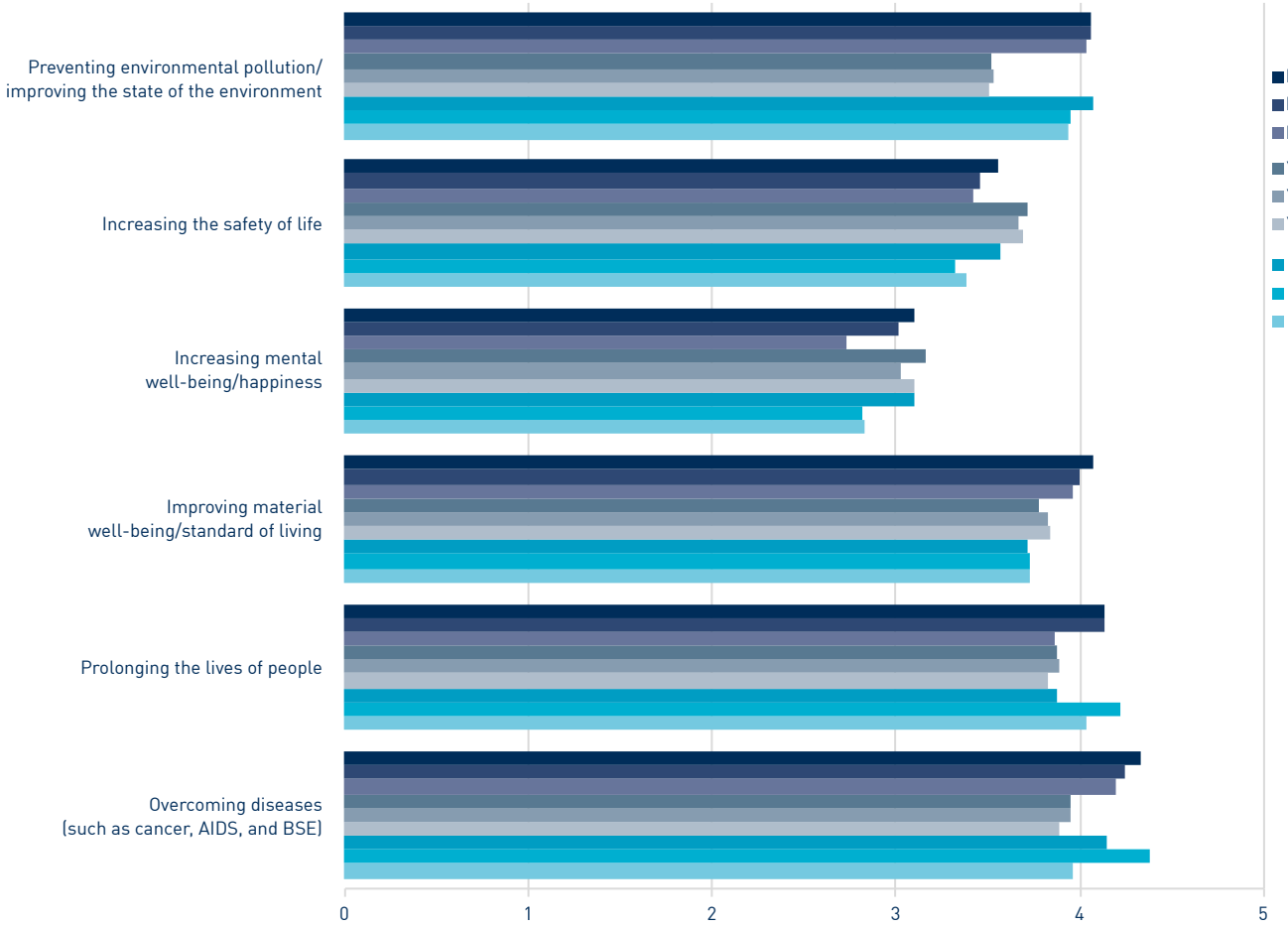


SURVEY GRAPH 2.7

Impact of development in technology on the quality of life.

(Question presented: Tell us whether you agree or disagree with the following statements when discussing the issue of science and technology influencing societal development?

1 = Fully disagree,
2 = Somewhat disagree,
3 = Difficult to say,
4 = Somewhat agree,
5 = Fully agree).

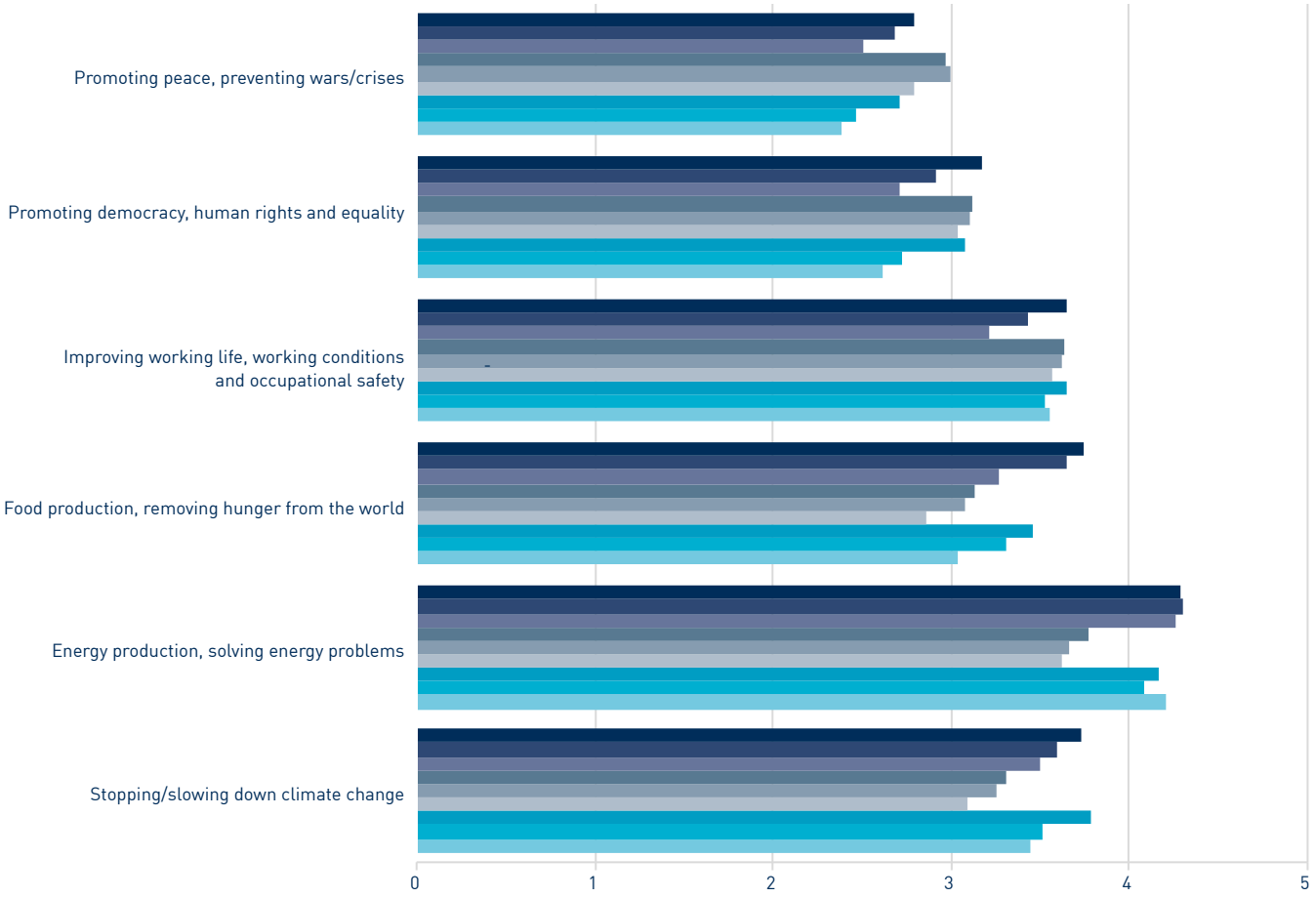


SURVEY GRAPH 2.8

Assessment of the capacity of science to resolve problems faced by humankind, Part 1.

(Question presented: How would you rate the ability of science and technology to resolve problems and to significantly help mankind in dealing with various matters?

1 = Entirely unable,
2 = Not very good,
3 = Difficult to say,
4 = Fairly good,
5 = Very good).

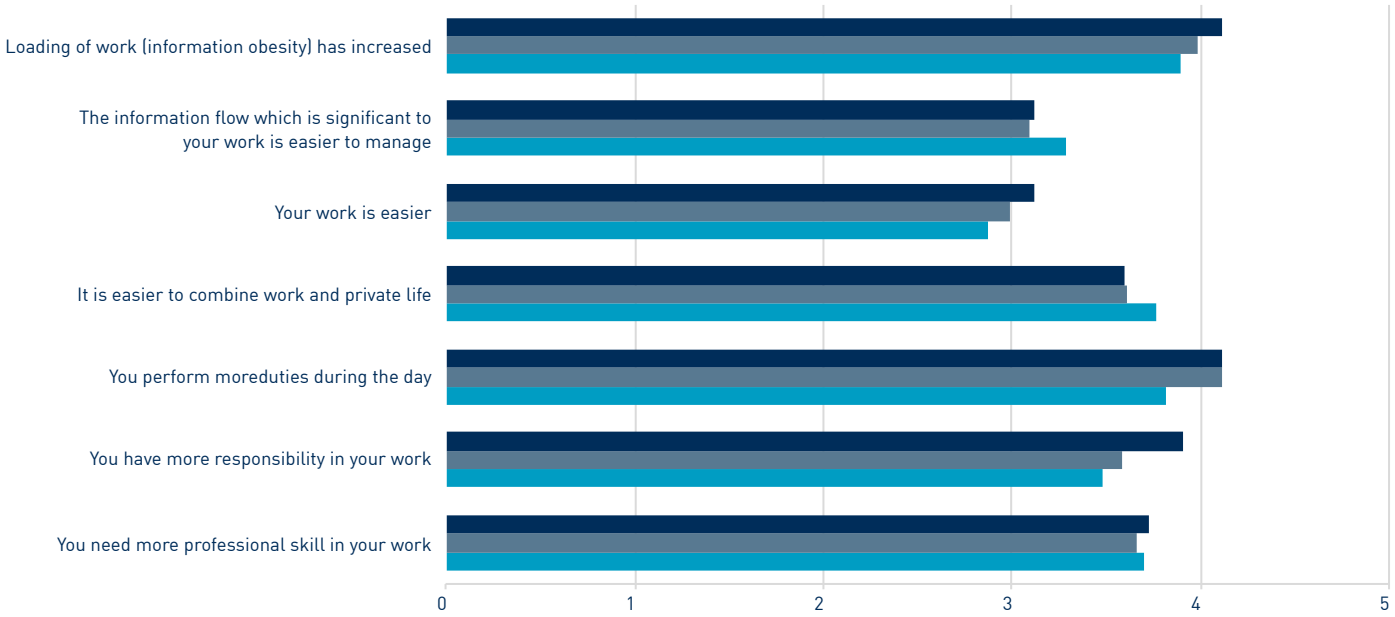


SURVEY GRAPH 2.9

Assessment of the capacity of science to resolve problems faced by humankind, Part 2.

(Question presented: How would you rate the ability of science and technology to resolve problems and to significantly help humankind in dealing with various matters?

1 = Entir ely unable,
2 = Not very good,
3 = Difficult to say,
4 = Fairly good,
5 = Very good).

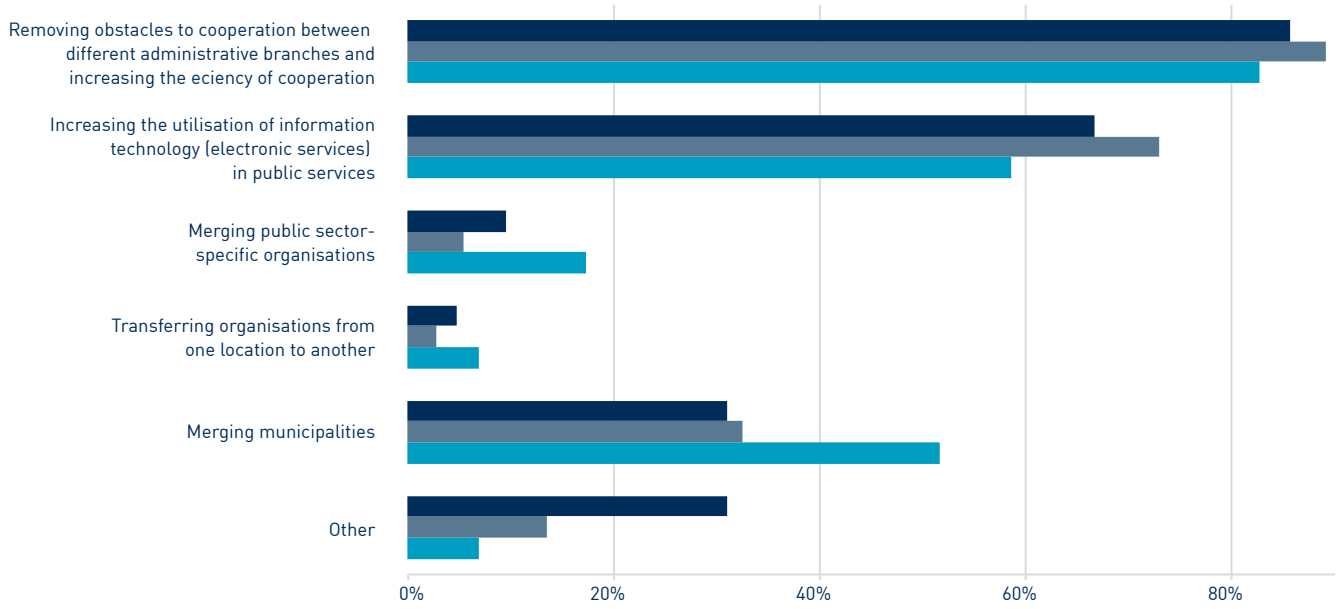


SURVEY GRAPH 2.10

TEK Members' assessments regarding the impact of information technology on their work methods.

(Question presented: Considering the use of ICT, such as computers, the Internet or e-mail, how has it changed your work methods? Do you agree or disagree with the following statements?

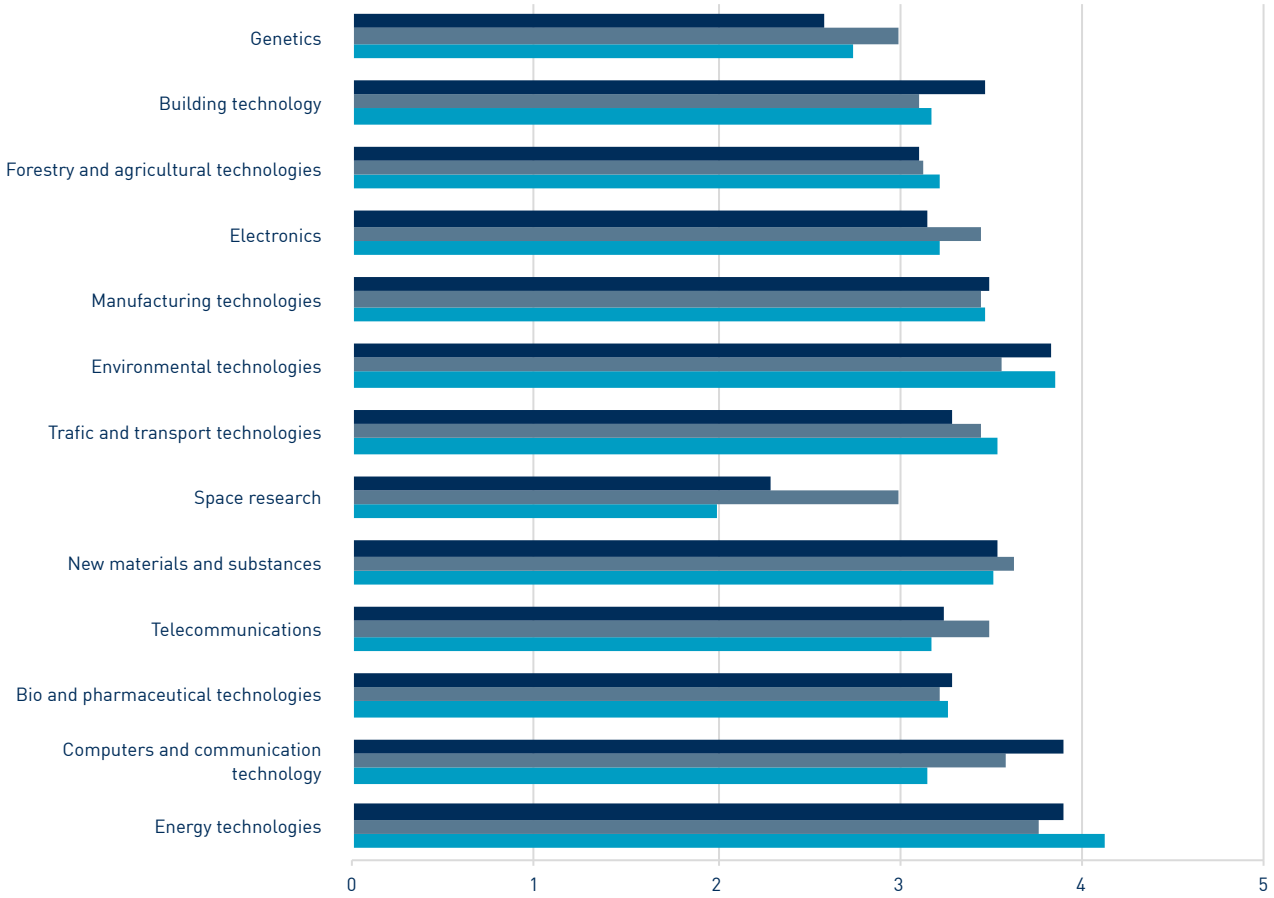
5 = Fully agree,
4 = Somewhat agree,
3 = Difficult to say,
2 = Somewhat disagree,
1 = Fully disagree).



SURVEY GRAPH 2.11

Politicians' estimates on how to improve productivity in the public sector.

(Question presented: Improving productivity in the public sector is one of the central challenges for our society to rise to. Of the following, which would be the most effective to improve productivity?)

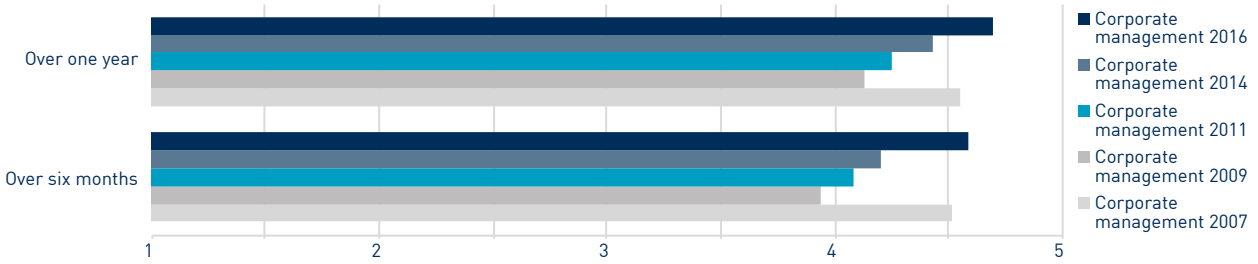


SURVEY GRAPH 2.12

Product development investment trends.

(Question presented: The following is a list of fields that are currently developing new technology. How do you see your enterprise's R&D investments development in each field of investment during the next 6 months in relation to the general development of your enterprise's R&D investments?

1 = The technology in question is not included in our business,
2 = We will invest considerably below the average,
3 = We will invest below the average,
4 = Difficult to say,
5 = We will invest above the average,
6 = We will invest considerably above the average).



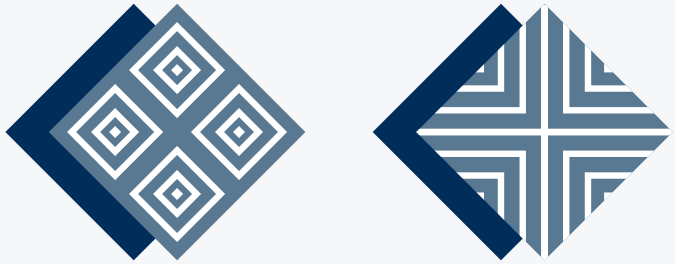
SURVEY GRAPH 2.13

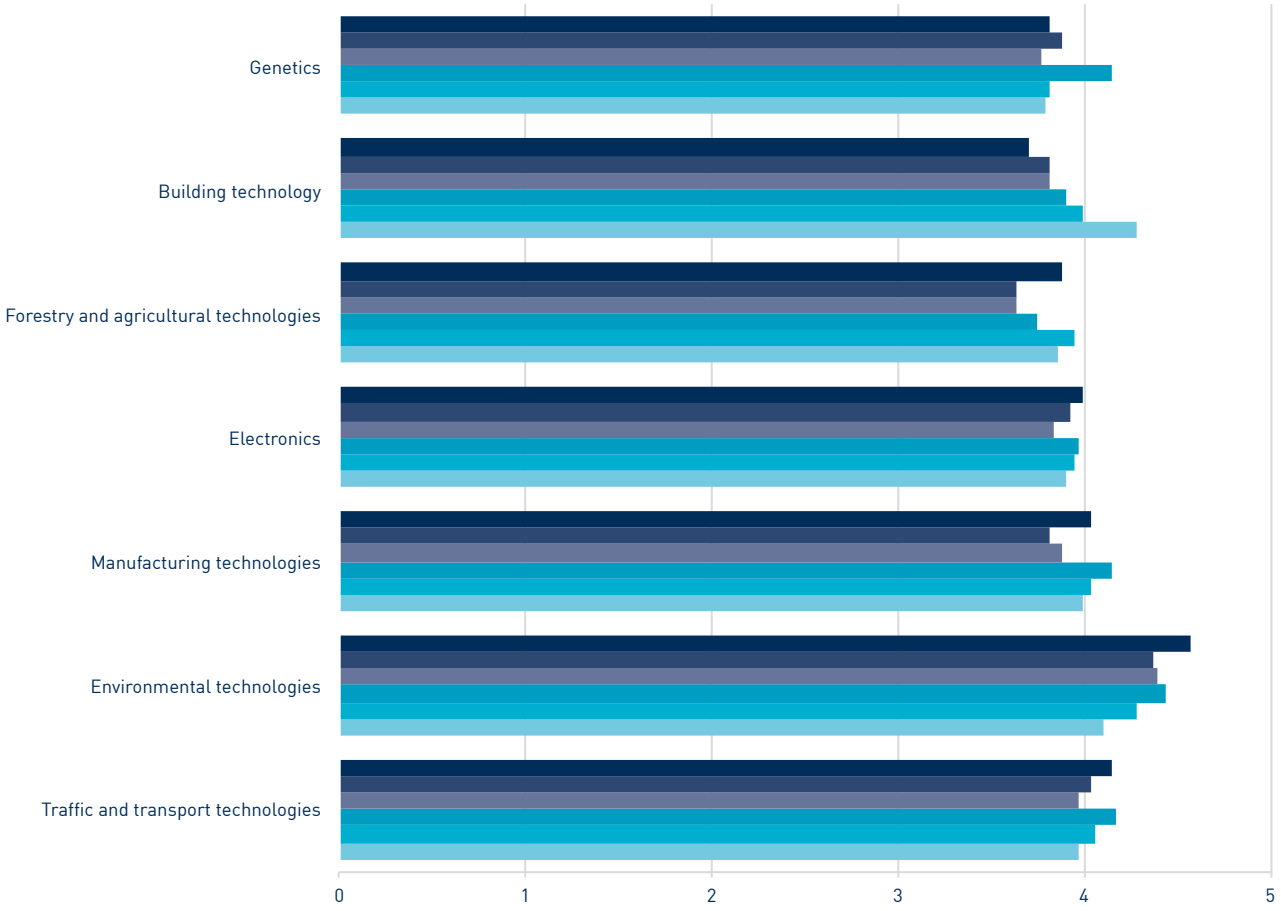
Product development investment trends.

(Question presented: How do you see the R&D investment of your enterprise developing over the next 6 months? And over the next 12 months?

1 = It will decrease considerably,
2 = It will decrease,
3 = Difficult to say,
4 = It will increase,
5 = It will increase considerably).

INNOVATIVE SOCIETY



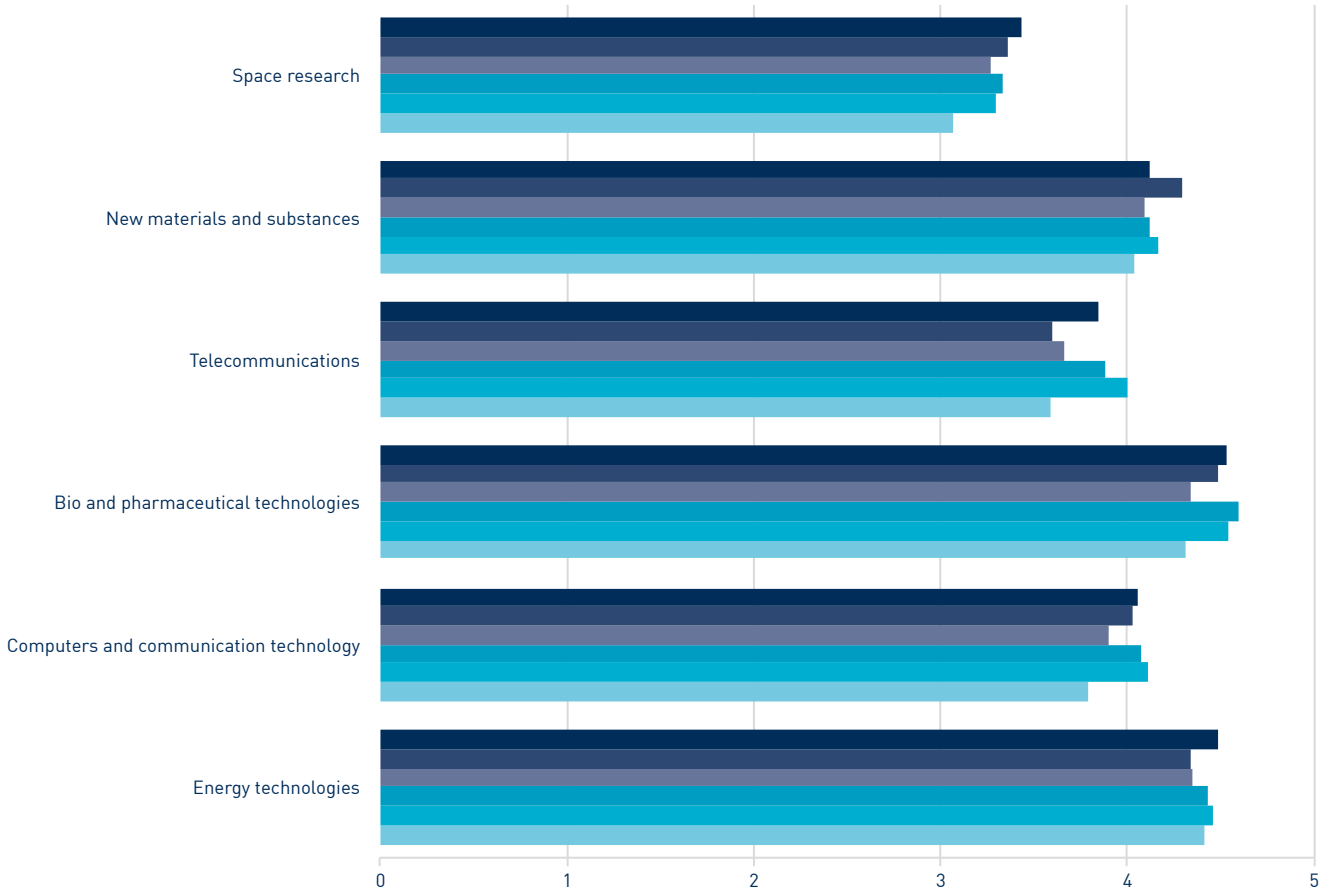


SURVEY GRAPH 3.1

Technology development and the quality of life, Part 1.

(Question presented: The following is a list of fields that are currently developing new technology. Do you believe that development in each of the fields will improve the quality of life during the coming 20 years? Or do you think this development will have no significance? Or will things get worse as a result?

5 = It will improve things considerably,
4 = It will improve things,
3 = Difficult to say,
2 = It will make things worse
1 = It will make things considerably worse).



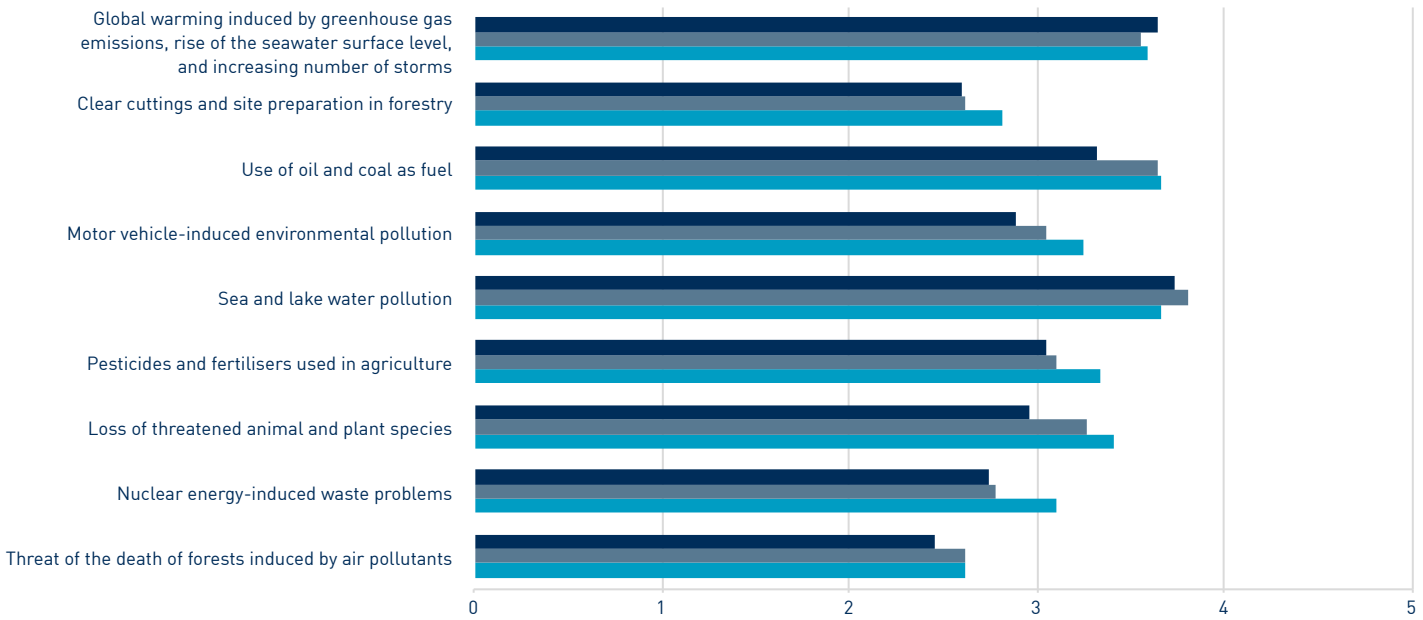
SURVEY GRAPH 3.2

Technology development and the quality of lif e, Part 2.

(Question presented: The following is a list of fields that are currently developing new technology. Do you believe that development in each of the fields will improve the quality of life during the coming 20 years? Or do you think this development will have no significance? Or will things get worse as a result?

5 = It will improve things considerably,
4 = It will improve things,
3 = Difficult to say,
2 = It will make things worse
1 = It will make things considerably worse).

SUSTAINABLE DEVELOPMENT

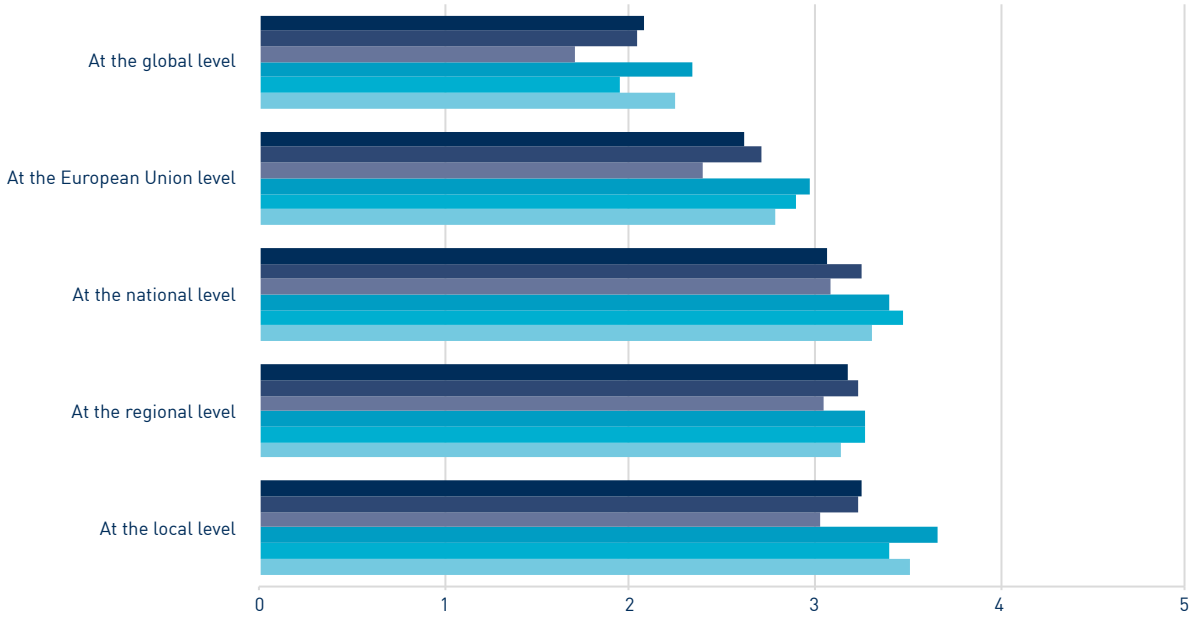


SURVEY GRAPH 4.1

Attitudes towards environmental threats.

(Question presented: Some environmental questions are listed below. Indicate alongside each one how serious you consider this problem to be in Finland. Select the number of the alternative closest to your own view.

1 = This matter is not important nowadays,
2 = This matter is important but we have it under control and no harm will result from it,
3 = This matter is a problem and more attention should be paid to it than is done at present,
4 = The matter is serious and requires immediate action,
5 = The matter is so serious that it amounts to a catastrophe.)



SURVEY GRAPH 4.2

Assessments of the Finnish authorities' actions in environmental protection at various levels.

(Question presented: Do the public authorities act efficiently at the following levels for environmental protection?

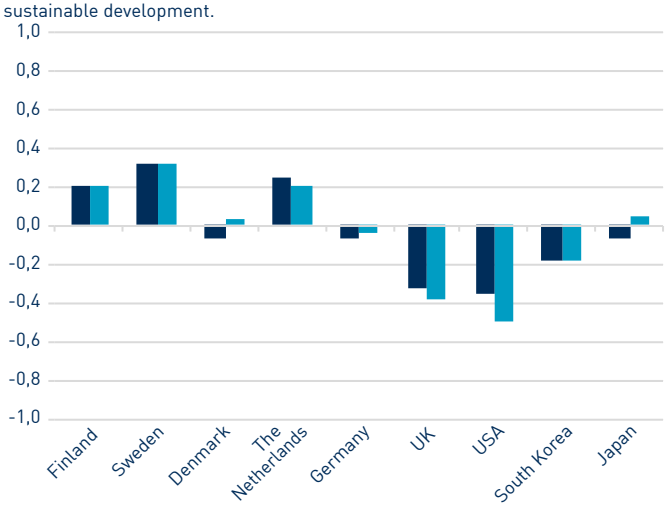
1 = Inefficiently,
2 = Fairly inefficiently,
3 = Difficult to say,
4 = Fairly efficiently,
5 = Efficiently).

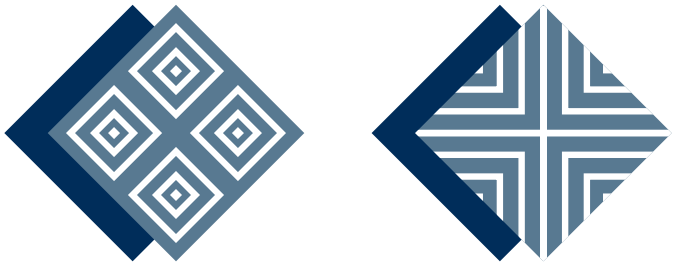
APPENDIX 2. STATISTICAL INICATORS

Overall index. Relative ranking of the comparison countries on information, knowledge, knowledge-value and sustainable social development based on the respective indicators. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

OVERALL INDEX.

The reference group countries' proportional ratings in accordance with the indices describing the properties and development dimensions of information society, knowledge society, knowledge-value society and society based on sustainable development.



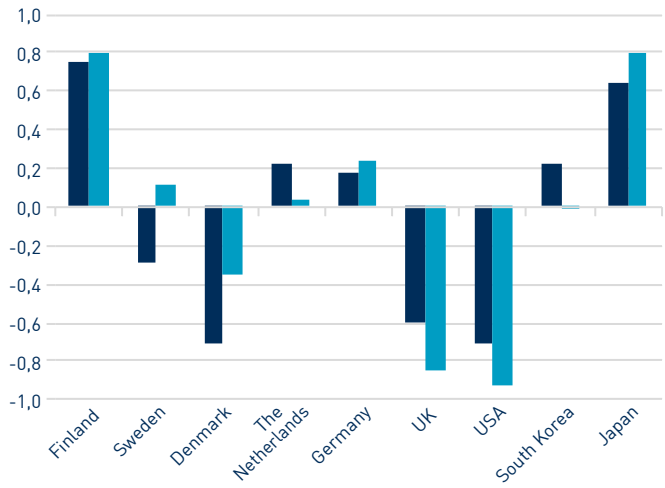


COMPETENCE AND CREATION OF KNOWLEDGE

Indicator 1.19. Relative ranking of the comparison countries on basic education, all-round education and competence, and techno-scientific skill as described by the indices. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

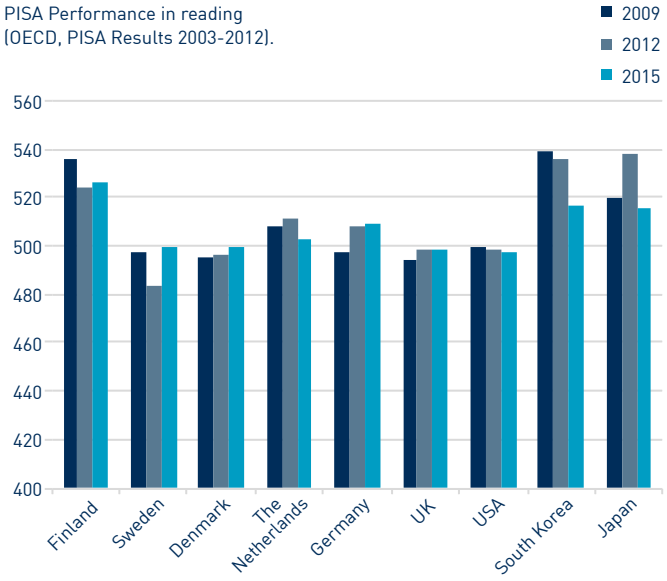
INDICATOR 1.19.

Relative ranking of the comparison countries on basic education, all-round education and skill, and scientific-technological skill, overall indicator



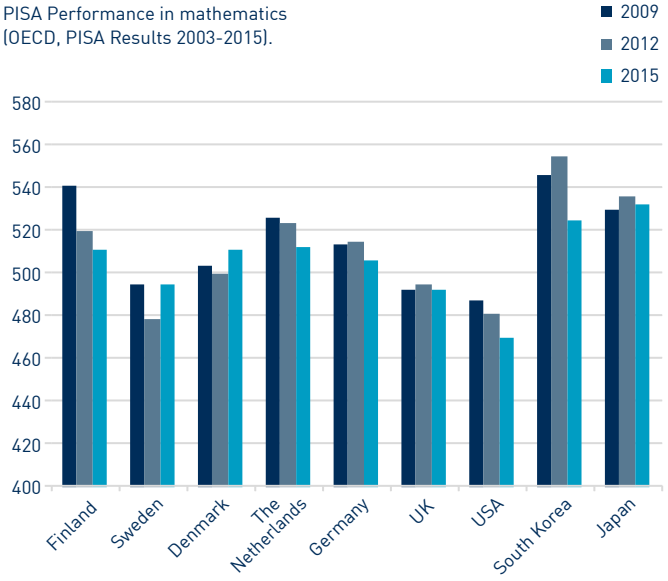
INDICATOR 1.1.

PISA Performance in reading
(OECD, PISA Results 2003-2012).



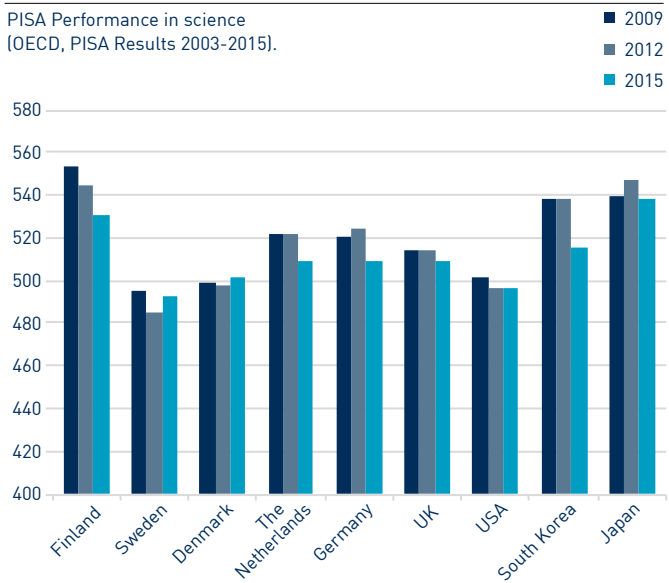
INDICATOR 1.2

PISA Performance in mathematics
(OECD, PISA Results 2003-2015).



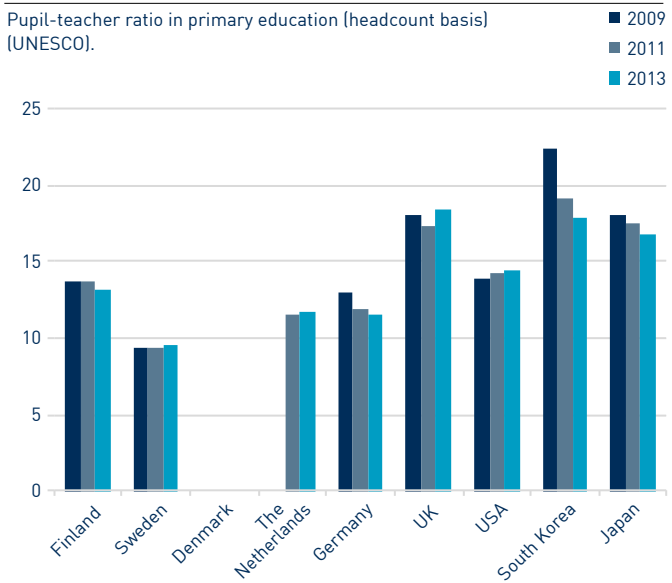
INDICATOR 1.3.

PISA Performance in science
(OECD, PISA Results 2003-2015).



INDICATOR 1.4.

Pupil-teacher ratio in primary education (headcount basis)
(UNESCO).



Basic education

Indicator 1.1. Young people's reading literacy in the PISA study.
PISA Performance in reading, http://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf, OECD, PISA Results 2003–2015.

Indicator 1.2. Young people's mathematical skills in the PISA study.
PISA Performance in mathematics, http://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf, OECD, PISA Results 2003–2015.

Indicator 1.3. Young people's scientific skill in the PISA survey (OECD, PISA Results 2003–2012).
PISA Performance in science, http://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf, OECD, PISA Results 2003–2015.

Indicator 1.4. Student/teacher ratio in primary-level education. Pupil-teacher ratio in secondary education (headcount basis).
Primary school pupil-teacher ratio is the average number of pupils per teacher in primary school, UNESCO.

Indicator 1.5. Student/teacher ratio in secondary-level education. Pupil-teacher ratio in secondary education (headcount basis).
Secondary school pupil-teacher ratio is the number of pupils enrolled in secondary school divided by the number of secondary school teachers (regardless of their teaching assignment), UNESCO.

General education and skills

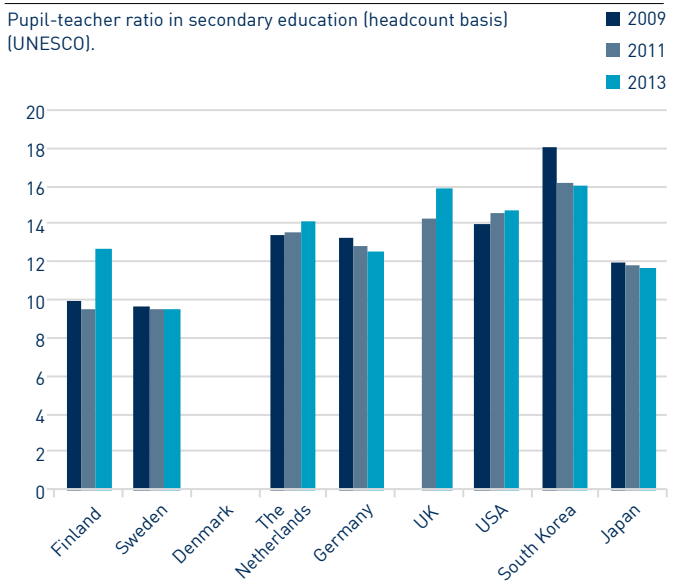
Indicator 1.6. Share of educational expenditure of GDP, per cent.
Public expenditure on education as a percentage of GDP, eurostat.

Indicator 1.7. Participation in lifelong learning percentage of people aged 25–64.
Life-long learning: Adult participation in education and training, percentage of the population aged 25–64 participating in education and training over the four weeks prior to the EU Labour Force Survey, Eurostat.

Indicator 1.8. Percentage of the working adult population (25–64 years of age) with a third-level education.
Population with higher education (percentage of people aged 25–64). Those who have completed tertiary education aged 25–64 as a percentage of the population of that age group. Tertiary education includes both tertiary-type "A programmes", which are largely theoretically-based and designed to provide qualifications for entry to advanced research programmes and professions with high skill requirements, as well as tertiary-type "B programmes" which are classified at the same level of competencies as tertiary-type A programmes but are more occupationally-oriented and lead to direct labour market access. OECD Education at a Glance.

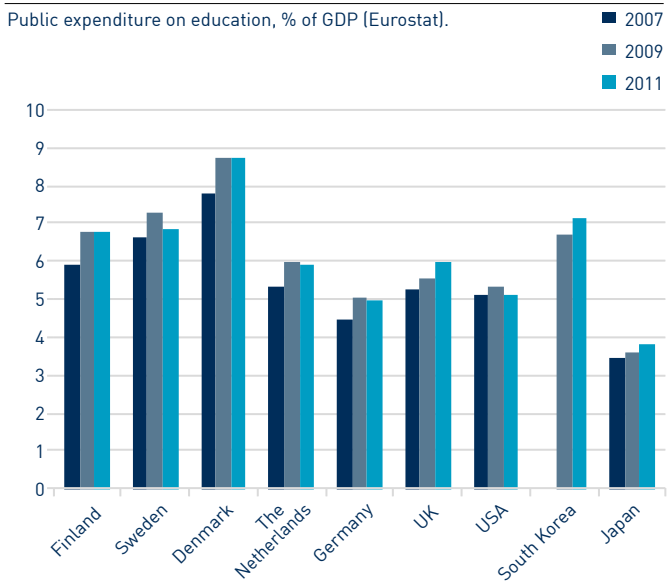
INDICATOR 1.5.

Pupil-teacher ratio in secondary education (headcount basis) (UNESCO).



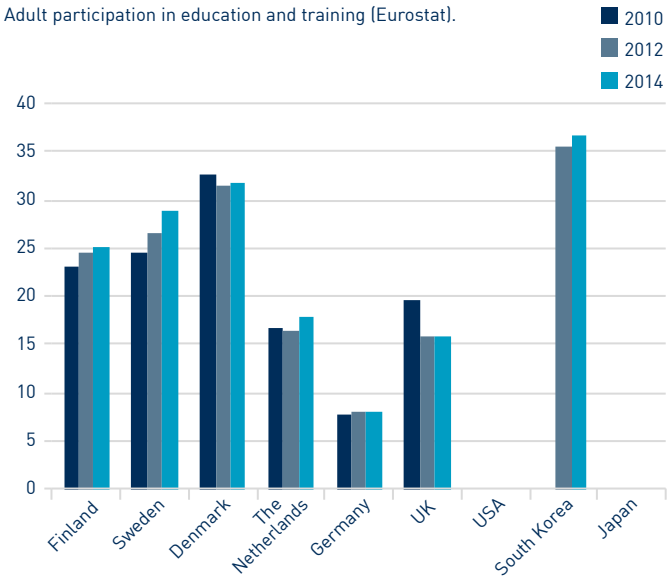
INDICATOR 1.6.

Public expenditure on education, % of GDP (Eurostat).



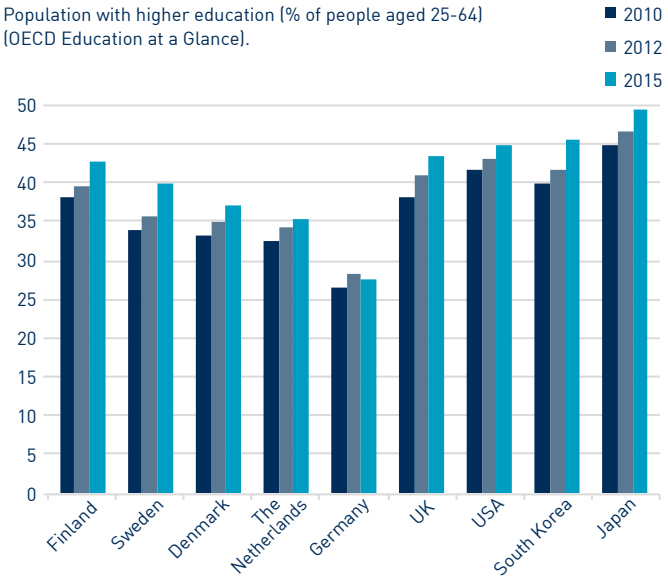
INDICATOR 1.7.

Adult participation in education and training (Eurostat).



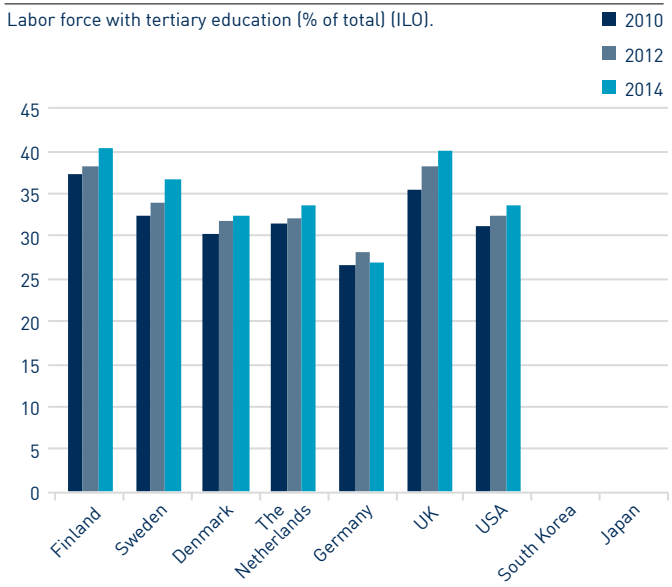
INDICATOR 1.8.

Population with higher education (% of people aged 25-64) (OECD Education at a Glance).



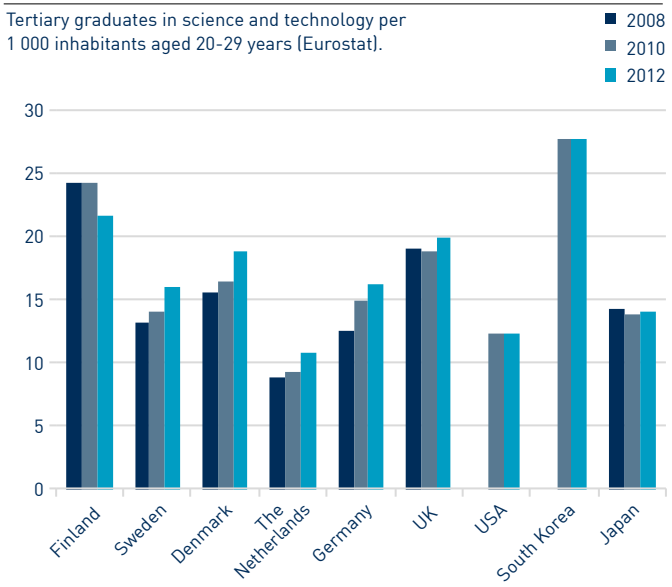
INDICATOR 1.9.

Labor force with tertiary education (% of total) (ILO).



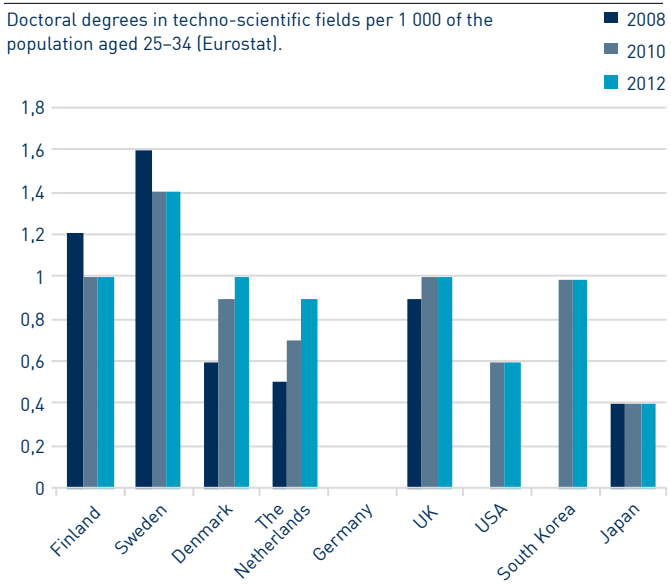
INDICATOR 1.10.

Tertiary graduates in science and technology per 1 000 inhabitants aged 20-29 years (Eurostat).



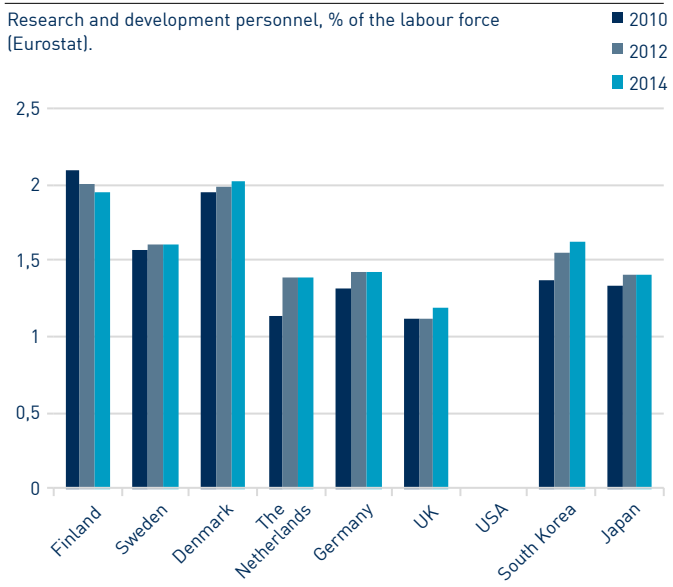
INDICATOR 1.11.

Doctoral degrees in techno-scientific fields per 1 000 of the population aged 25–34 (Eurostat).



INDICATOR 1.12.

Research and development personnel, % of the labour force (Eurostat).



Scientific-technical skill

Indicator 1.9. Percentage of employed people with a third-level degree. Labour force with tertiary education (% of people aged 25–64), Labour force with tertiary education is the share of the total labour force that attained or completed tertiary education as the highest level of education. International Labour Organization ILO.

Indicator 1.10. New degrees in science and technology fields, ‰ of people aged 20–29.
Tertiary graduates in science and technology per 1,000 of the population aged 20–29 years. It includes new tertiary graduates in a calendar year from both public and private institutions completing graduate and post graduate studies compared to an age group that corresponds to the typical graduation age in most countries. It does not correspond to the number of graduates in these fields who are available in the labour market in this specific year. The levels and fields of education and training used follow the 1997 version of the International Standard Classification of Education (ISCED97) and the Eurostat Manual of fields of education and training (1999). Eurostat.

Indicator 1.11. Doctoral degrees in science and technology fields, ‰ of people aged 25–34.
Doctoral degrees in techno-scientific fields per thousand of the population aged 25–34. Graduates (ISCED 6) from science, mathematics, computing, engineering, manufacturing & construction fields per 1000 of the population aged 25–34. Eurostat.

Indicator 1.12. Research and development investment proportion of R&D personnel of the total labour force, %. Share of research and development personnel, in full-time equivalents (% of the labour force). R&D personnel include all persons employed directly on R&D, plus persons supplying direct services to R&D, such as managers, administrative staff and office staff. The measure shown is total R&D personnel in full time equivalents as a percentage of the economic active population. Please note that the calculation of the measure has changed from being based on head count to full time equivalents from January 2010. Eurostat.

Indicator 1.13. Proportion of female scientists, per cent.
Share of women researchers among total researchers, in head count %. Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems, and in the management of the projects concerned. Eurostat.

Indicator 1.14. Labour force employed by high and medium-high technology industry, percentage of the total labour force.
Employment in high- and medium-high-technology manufacturing, % of total employment.
The definition of high- and medium-high technology manufacturing sectors is based on the OECD definition (itself based on the ratio of R&D expenditure to GDP). Statistics on high-tech industry uses various other domains and sources of Eurostat's official statistics, Eurostat.

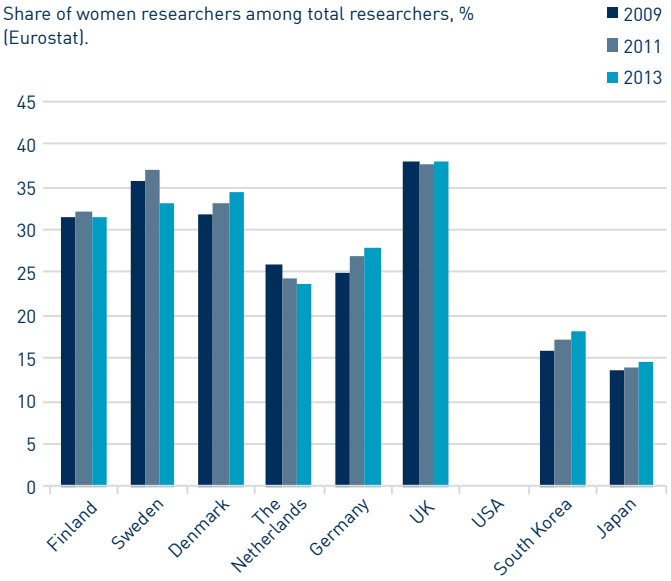
Indicator 1.15. Labour force employed by high technology industry and competence-intensive services, percentage of the total labour force.
Employment in high-technology manufacturing sectors and in knowledge-intensive high-technology services (I64, K72, K73), Share of total employment (%). Statistics on high-tech industry and knowledge-intensive services uses various other domains and sources of Eurostat's official statistic. Eurostat.

Combined indicators

Indicator 1.16. Relative ranking of the comparison countries on basic education based on the PISA study and on the student/teacher ratio. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

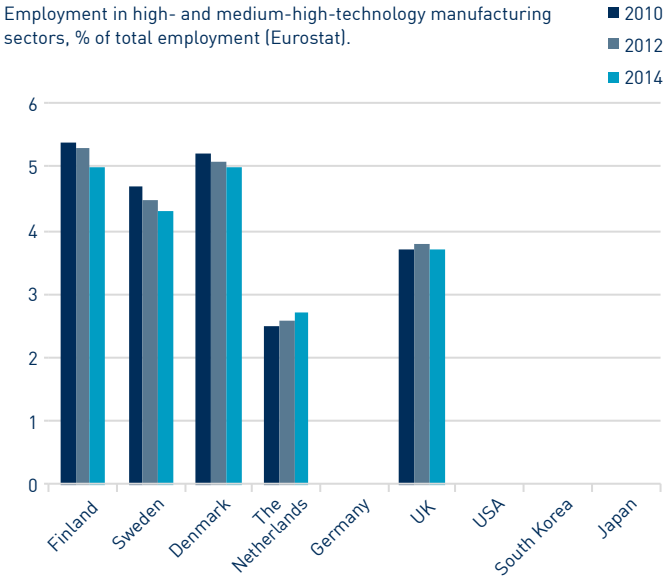
INDICATOR 1.13.

Share of women researchers among total researchers, % (Eurostat).



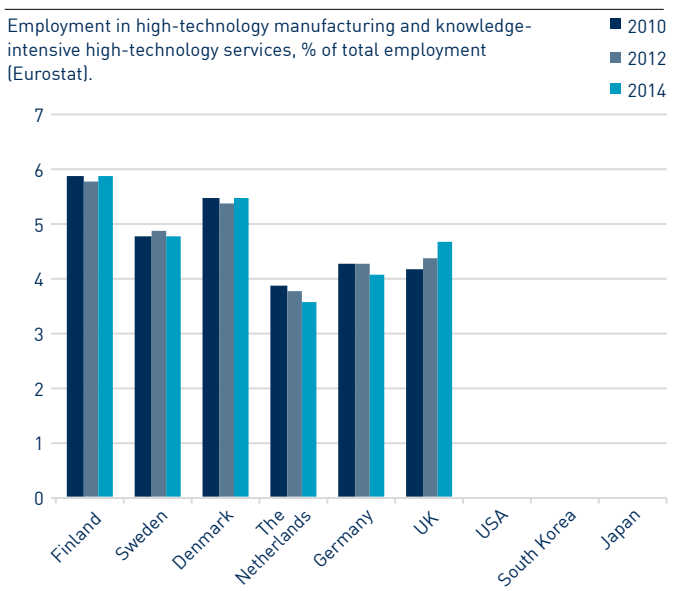
INDICATOR 1.14.

Employment in high- and medium-high-technology manufacturing sectors, % of total employment (Eurostat).



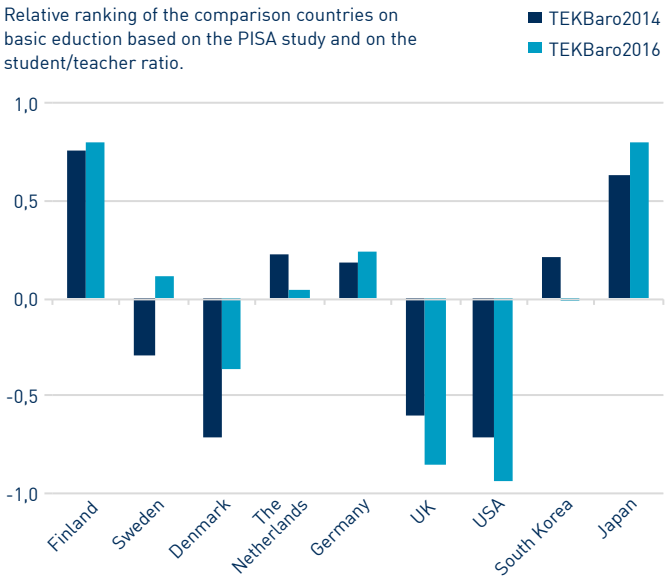
INDICATOR 1.15.

Employment in high-technology manufacturing and knowledge-intensive high-technology services, % of total employment (Eurostat).



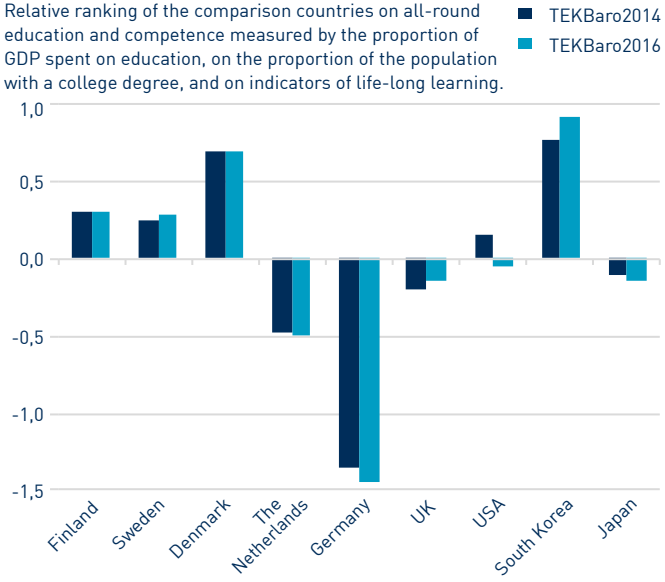
INDICATOR 1.16.

Relative ranking of the comparison countries on basic eduction based on the PISA study and on the student/teacher ratio.



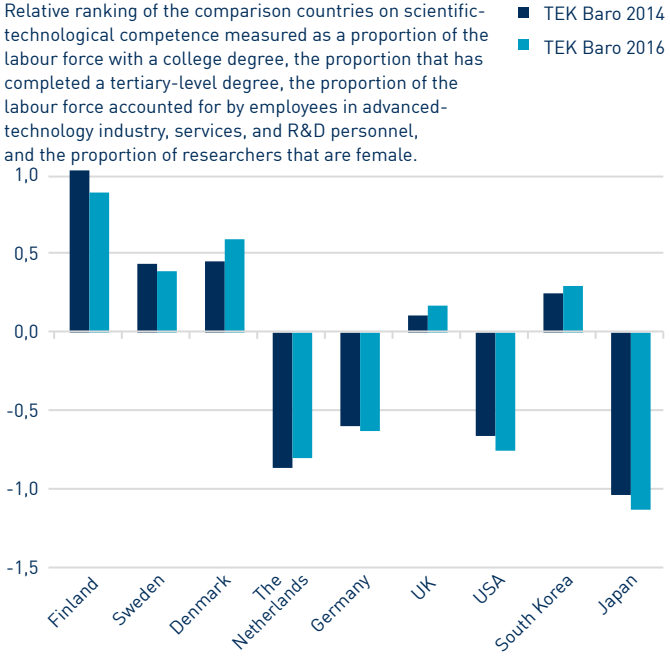
INDICATOR 1.17.

Relative ranking of the comparison countries on all-round education and competence measured by the proportion of GDP spent on education, on the proportion of the population with a college degree, and on indicators of life-long learning.



INDICATOR 1.18.

Relative ranking of the comparison countries on scientific-technological competence measured as a proportion of the labour force with a college degree, the proportion that has completed a tertiary-level degree, the proportion of the labour force accounted for by employees in advanced-technology industry, services, and R&D personnel, and the proportion of researchers that are female.



Indicators 1.17. Relative ranking of the comparison countries on all-round education and competence measured by the proportion of GDP spent on education, on the proportion of the population with a college degree, and on indicators of lifelong learning. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

Indicator 1.18. Relative ranking of the comparison countries on techno-scientific competence measured as a proportion of the labour force with a college degree, the proportion that has completed a tertiary-level degree, the proportion of the labour force accounted for by employees in advanced-technology industry, services, and R&D personnel, and the proportion of researchers that are female. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

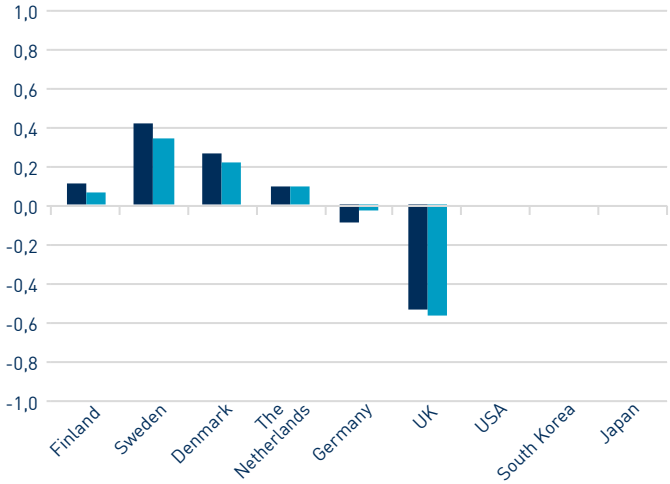
KNOWLEDGE SOCIETY DEVELOPMENT

Investment in research and product development

Indicator 2.29. Relative ranking of the comparison countries on investments and product development, information and communications technology, and application of new knowledge. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

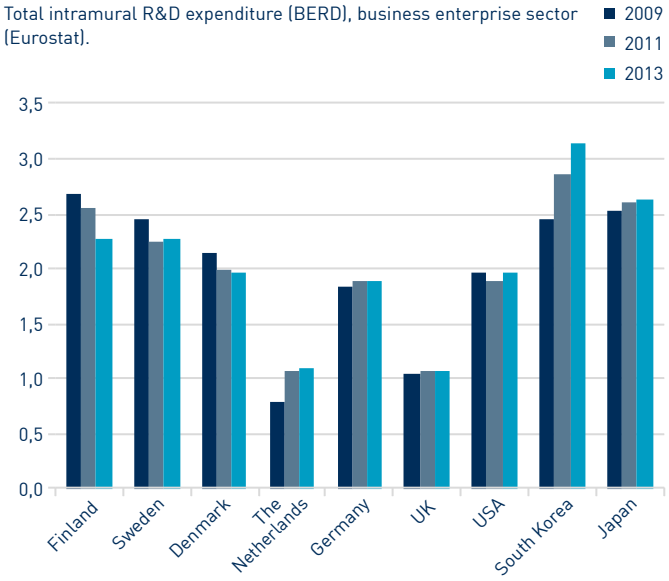
INDICATOR 2.29.

Relative ranking of the comparison countries on investments and product development, information and communications technology, and application of new knowledge, overall indicator.



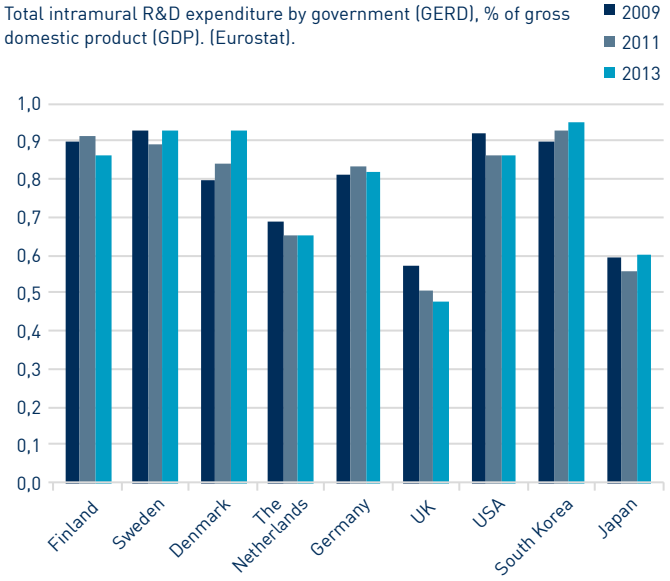
INDICATOR 2.1.

Total intramural R&D expenditure (BERD), business enterprise sector (Eurostat).



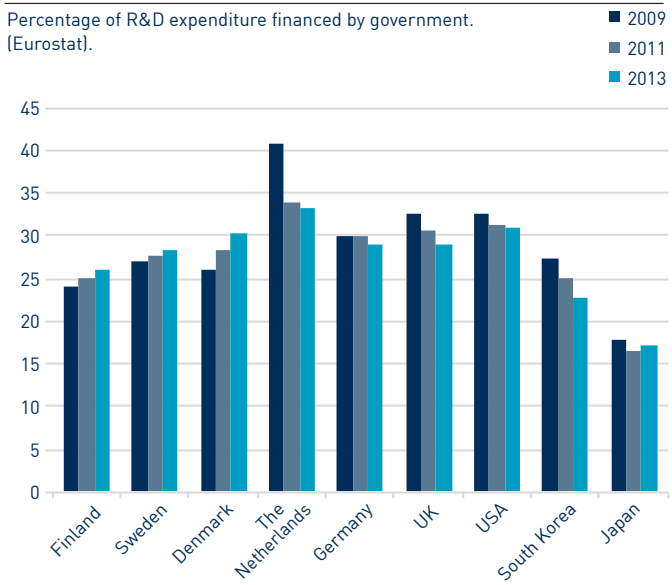
INDICATOR 2.2.

Total intramural R&D expenditure by government (GERD), % of gross domestic product (GDP). (Eurostat).



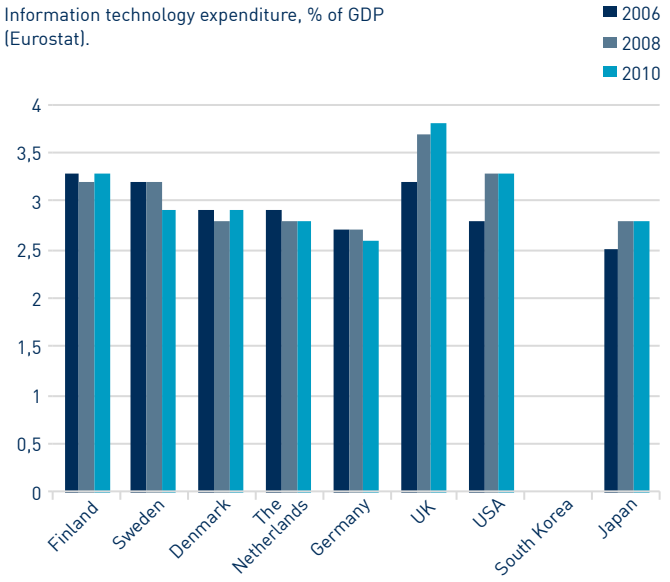
INDICATOR 2.3.

Percentage of R&D expenditure financed by government. (Eurostat).



INDICATOR 2.4.

Information technology expenditure, % of GDP (Eurostat).



Indicator 2.1. Companies' R&D expenditure, percentage of GDP.
Total intramural R&D expenditure by business sector (BERD), % of gross domestic product (GDP). R&D expenditures include all expenditures for R&D performed within the business enterprise sector (BERD) on the national territory during a given period, regardless of the source of funds. Eurostat.

Indicator 2.2. Public R&D expenditure, percentage of GDP.
Total intramural R&D expenditure by government (GERD), % of gross domestic product (GDP). Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications (Frascati Manual, 2002 edition, § 63). Eurostat.

Indicator 2.3. Share of public funding of R&D expenditure, per cent.
Gross domestic expenditure on R&D (GERD) by source of funds, government, percentage of GERD financed by government. Eurostat.

ICT expenditure

Indicator 2.4. Information technology expenditure, percentage of GDP.
Information technology expenditure in millions of euros and as a percentage of GDP. Eurostat.

Indicator 2.5. Expenditure on communications technology,
percentage of GDP.
Communications expenditure in millions of euros and as a percentage of GDP. Eurostat.

Use of information and communication technologies

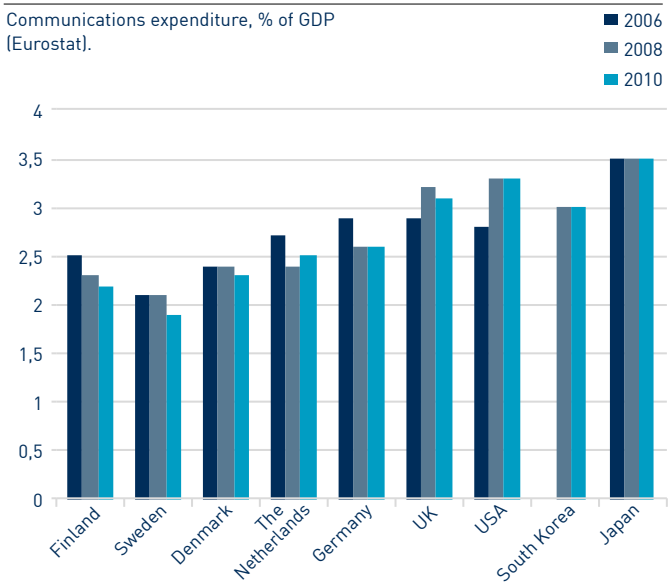
Indicator 2.6. Prevalence of fixed broadband in the whole population, percentage.
Fixed (wired) broadband subscriptions per 100 inhabitants, %. OECD Factbook 2014.

Indicator 2.7. Internet capacity utilisation rate in the whole population, percentage.
Individuals regularly using the internet, % of individuals aged 16 to 74. Regular use: at least once a week (i.e. every day or almost every day or at least once a week but not every day) on average within the last 3 months before the survey. Use includes all locations and methods of access and any purpose (private or work/business related). Eurostat.

Indicator 2.8. Internet capacity utilisation rate in the whole population, percentage.
Internet users (per 100 people). Internet users are individuals who have used the Internet (from any location) in the last 12 months. Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc. International Telecommunication Union, World Telecommunications/ ICT Development Report and database, and World Bank estimates.

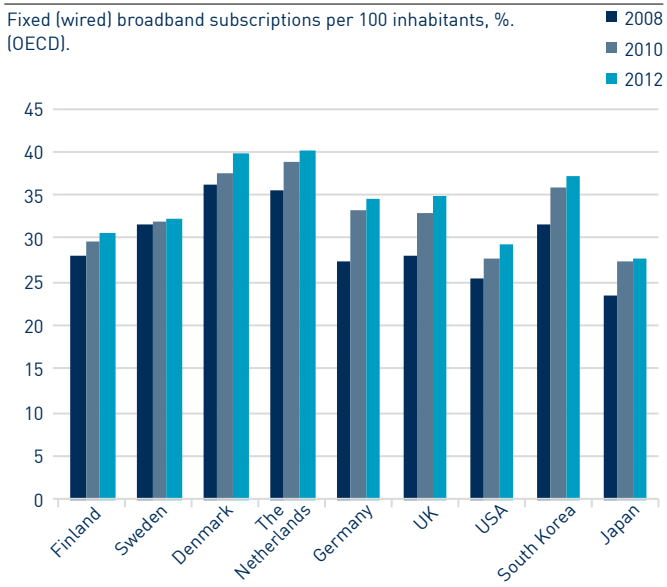
INDICATOR 2.5.

Communications expenditure, % of GDP
(Eurostat).



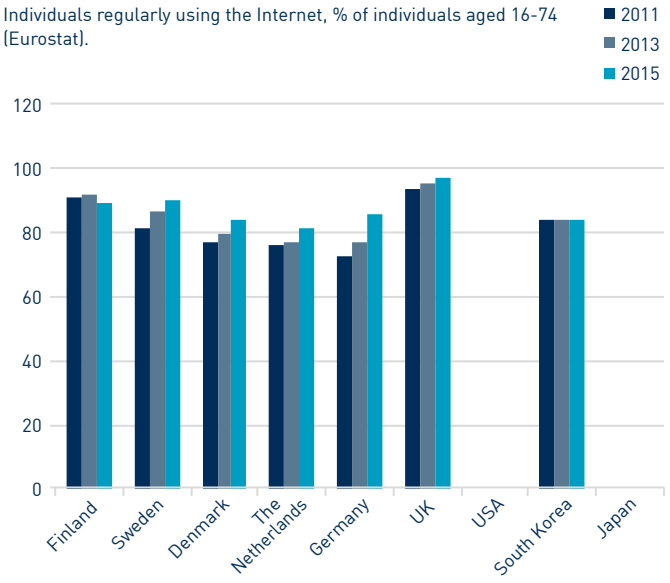
INDICATOR 2.6.

Fixed (wired) broadband subscriptions per 100 inhabitants, %.
(OECD).



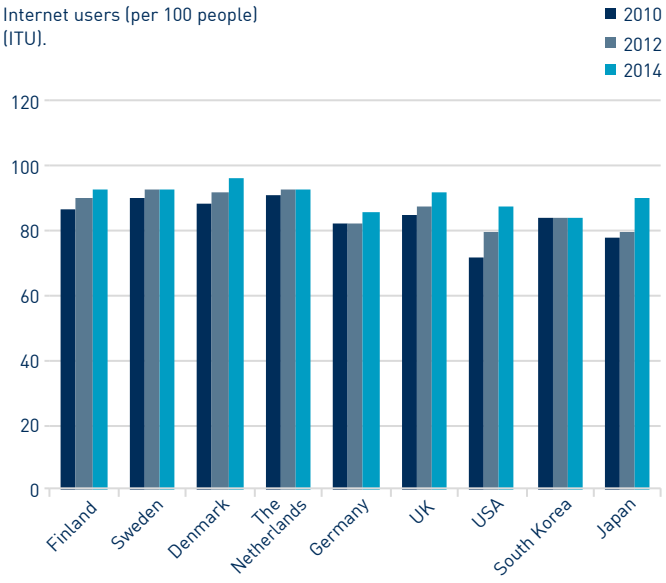
INDICATOR 2.7.

Individuals regularly using the Internet, % of individuals aged 16-74
(Eurostat).



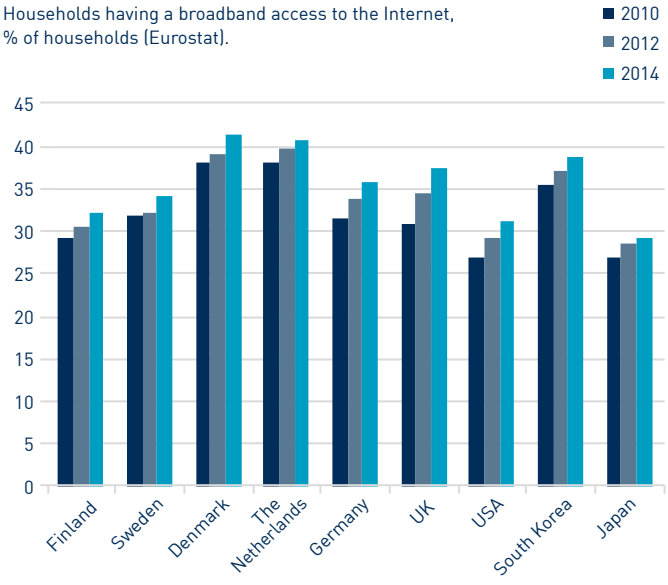
INDICATOR 2.8.

Internet users (per 100 people)
(ITU).



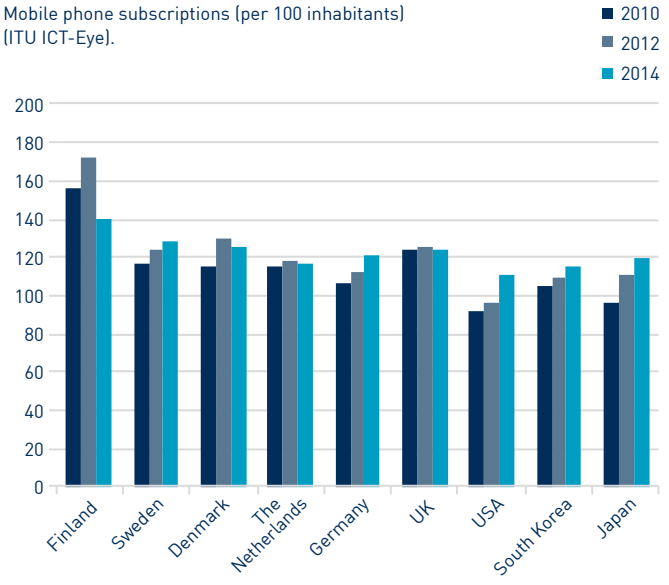
INDICATOR 2.9.

Households having a broadband access to the Internet, % of households (Eurostat).



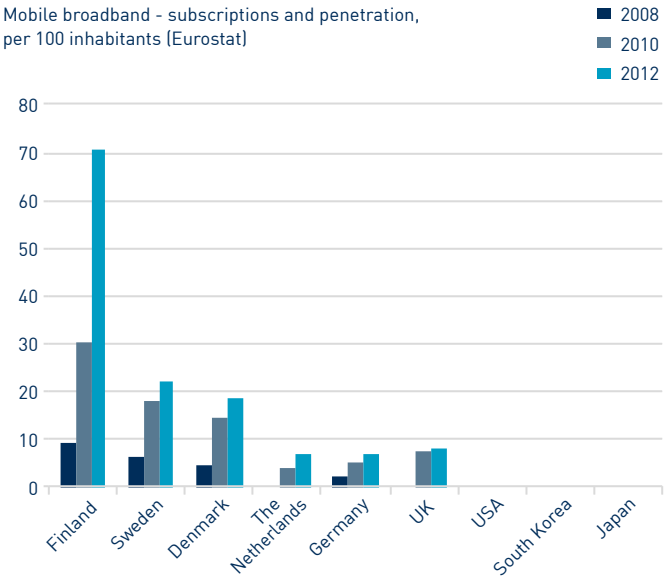
INDICATOR 2.10.

Mobile phone subscriptions (per 100 inhabitants) (ITU ICT-Eye).



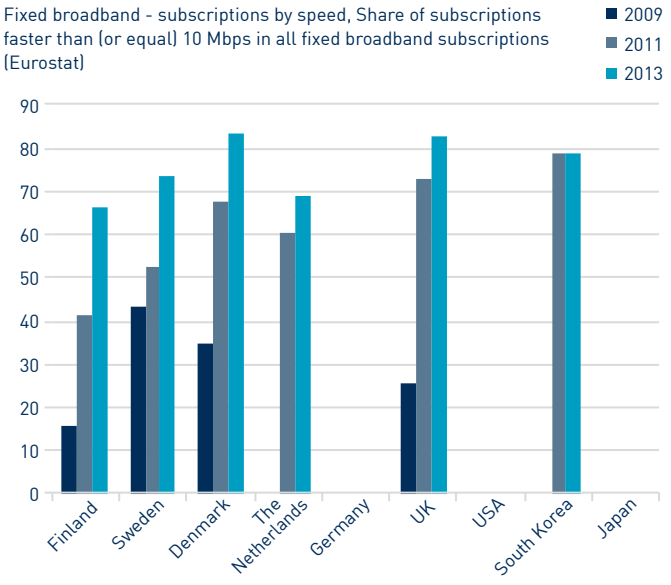
INDICATOR 2.11.

Mobile broadband - subscriptions and penetration, per 100 inhabitants (Eurostat)



INDICATOR 2.12.

Fixed broadband - subscriptions by speed, Share of subscriptions faster than (or equal) 10 Mbps in all fixed broadband subscriptions (Eurostat)



Indicator 2.9. Prevalence of broadband connections, percentage of households.
Households having broadband access to the Internet, % of households. The access to internet of households is measured by percentage of households that are connectable to the internet over broadband or a dial-up or ISDN connection. Some households may use more than one type of connection to connect to the internet. It covers all households having at least one member in the age group 16–74 years. Eurostat.

Indicator 2.10. Prevalence of mobile phones in the entire population, percentage.
Mobile phone subscriptions (per 100 inhabitants). The indicator of mobile phone penetration shows the number of subscriptions to public mobile telecommunication systems using cellular technology in thousands of subscriptions. Active pre-paid cards are treated as subscriptions. One person may have more than one subscription. ITU (ICT-Eye).

Indicator 2.11. Prevalence of mobile broadband in the entire population, percentage.
Mobile broadband subscriptions and penetration, per 100 inhabitants, Eurostat.

Indicator 2.12. Prevalence of fixed broadband, at least 10 Mbps, among the total population, percentage.
Fixed broadband: subscriptions by speed, Share of subscriptions faster than (or equal) 10 Mbps in all fixed broadband subscriptions, %. Eurostat.

Indicator 2.13. Prevalence of fixed broadband connections, at least 100 Mbps, among the total population, per cent.
Fixed broadband: subscriptions by speed, Share of subscriptions faster than (or equal) 100 Mbps in all fixed broadband subscriptions, %. Eurostat.

Indicator 2.14. Share of Internet users who have bought online, percentage.
Individuals having ordered/bought goods or services for private use over the Internet in the last three months, % of individuals. Eurostat.

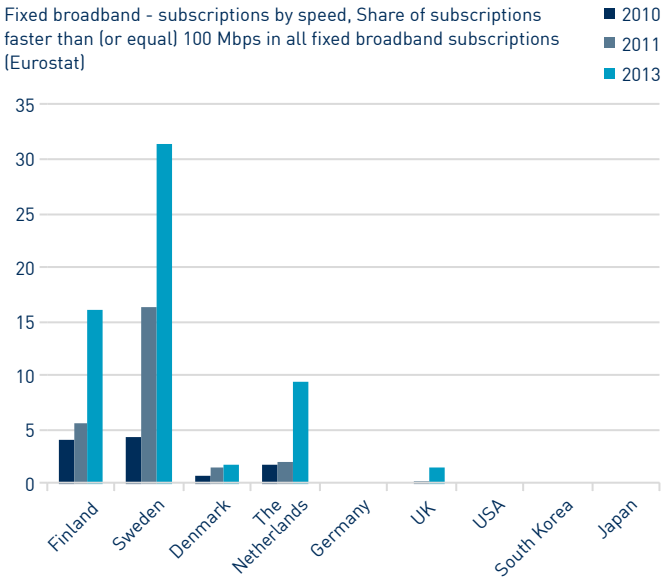
Indicator 2.15. Prevalence of private households with broadband connections, in the entire population, percentage. Fixed broadband subscriptions (per 100 people), Fixed broadband subscriptions refers to fixed subscriptions to high-speed access to the public Internet (a TCP/IP connection), at downstream speeds equal to, or greater than, 256 kbit/s. This includes cable modem, DSL, fibre-to-home/building, other fixed (wired)-broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband. This total is measured irrespective of the method of payment. It excludes subscriptions that have access to data communications (including the Internet) via mobile-cellular networks. It should include fixed WiMAX and any other fixed wireless technologies. It includes both residential subscriptions and subscriptions for organisations. International Telecommunication Union, World Telecommunication/ICT Development Report and database.

Electronic business transactions

Indicator 2.16. Share of companies buying online, excluding micro-sized enterprises and financing services, percentage of companies.
Enterprises purchasing via Internet and/or networks other than internet, % of enterprises. Percentage of enterprises having purchased online over the last calendar year. All enterprises, without financial sector (10 persons employed or more). Eurostat.

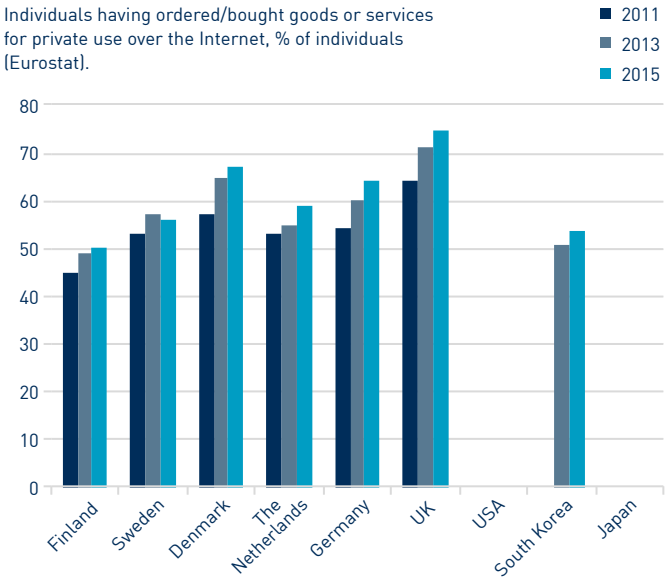
INDICATOR 2.13.

Fixed broadband - subscriptions by speed, Share of subscriptions faster than (or equal) 100 Mbps in all fixed broadband subscriptions (Eurostat)



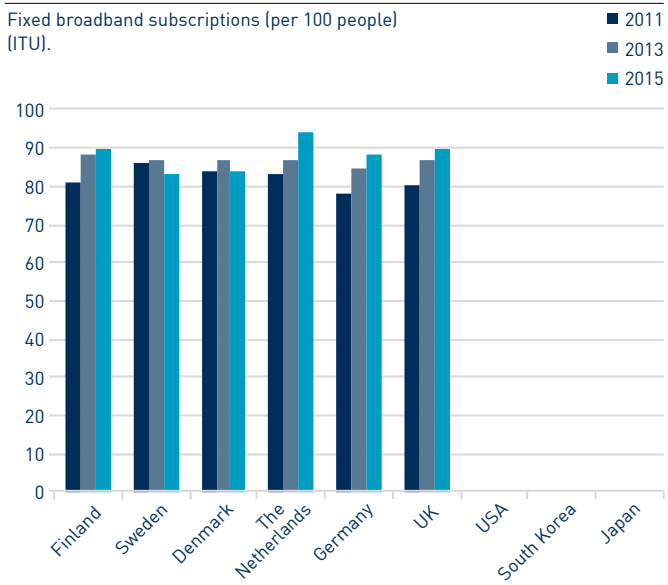
INDICATOR 2.14.

Individuals having ordered/bought goods or services for private use over the Internet, % of individuals (Eurostat).



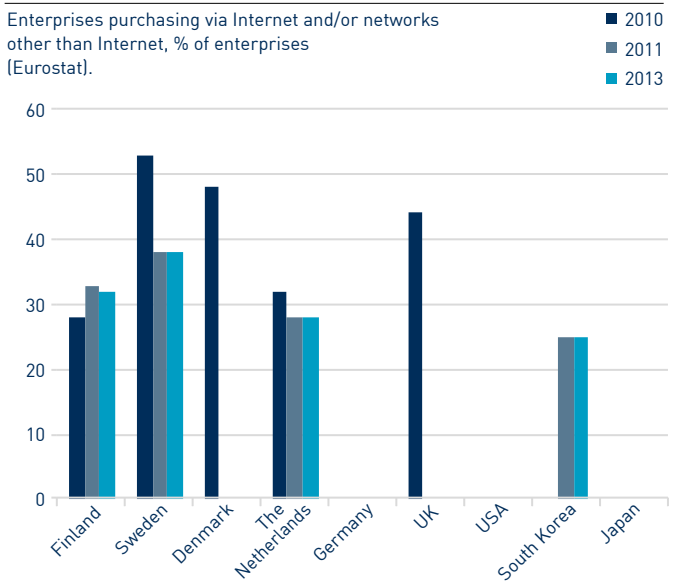
INDICATOR 2.15.

Fixed broadband subscriptions (per 100 people) (ITU).



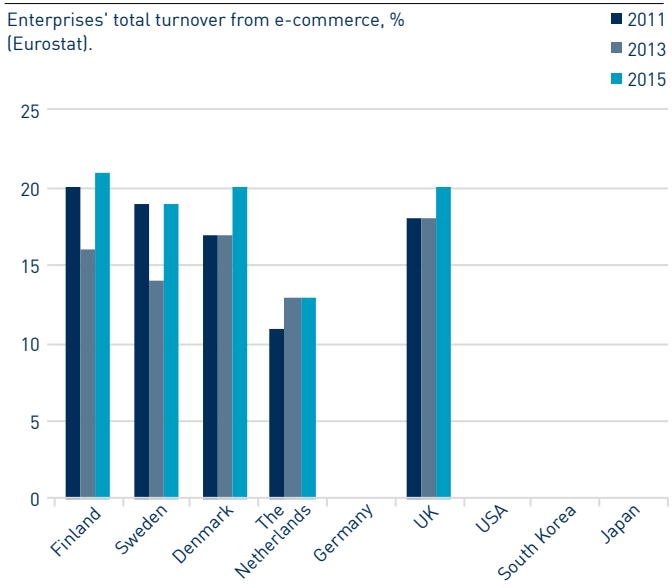
INDICATOR 2.16.

Enterprises purchasing via Internet and/or networks other than Internet, % of enterprises (Eurostat).



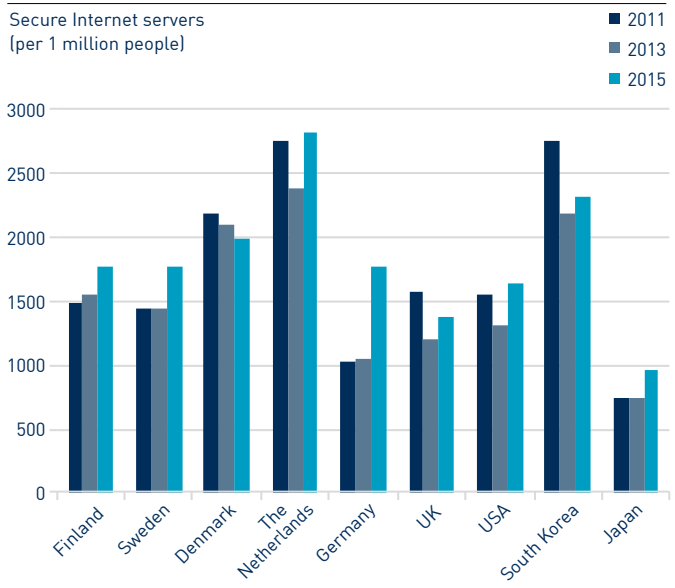
INDICATOR 2.17.

Enterprises' total turnover from e-commerce, % (Eurostat).



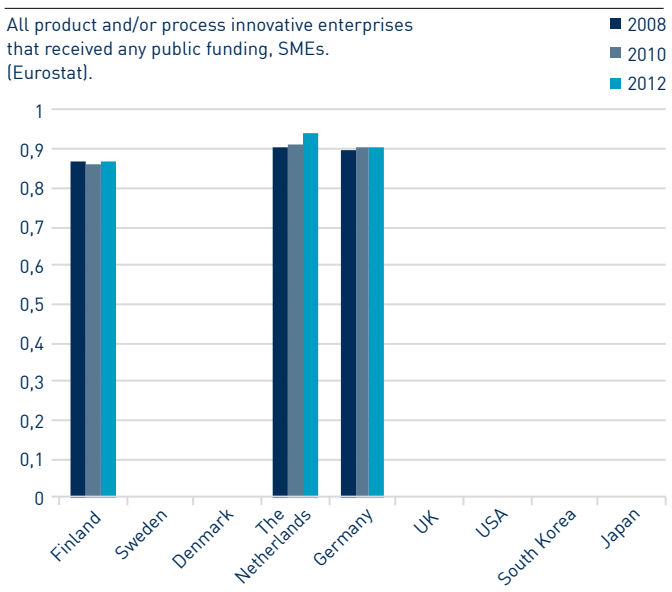
INDICATOR 2.18.

Secure Internet servers (per 1 million people)



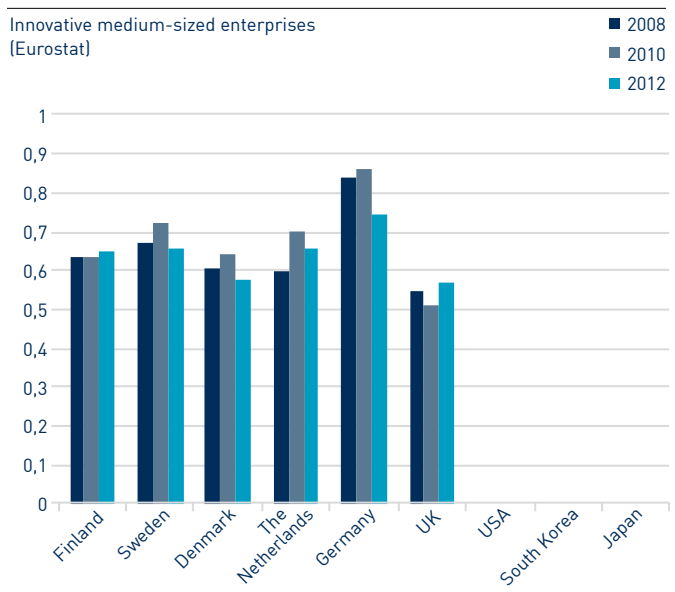
INDICATOR 2.19.

All product and/or process innovative enterprises that received any public funding, SMEs. (Eurostat).



INDICATOR 2.20.

Innovative medium-sized enterprises (Eurostat)



Indicator 2.17. Share of online sales of companies' turnover, excluding micro-sized enterprises and financing services, per cent. Enterprises' total turnover from e-commerce over the last calendar year, % of turnover. Value of purchases and sales by the Internet and/or networks other than the Internet. All enterprises, without financial sector (10 employed persons or more). Eurostat.

Indicator 2.18. Secure internet servers, per million inhabitants. Secure servers are servers using encryption technology in Internet transactions. Netcraft (http://www.netcraft.com/) and World Bank population estimates.

Application of new knowledge

Indicator 2.19. Proportion of innovative SMEs of companies that have received public R&D funding, per cent. All product and/or process innovative enterprises that received any public funding, SMEs, % of all enterprises. All NACE - Core NACE (NACE sections C, D, E, I and J and NACE divisions 51, 72, 74.2 and 74.3). Eurostat.

Indicator 2.20. Share of medium-sized companies engaged in innovative activities, percentage of all companies. Innovative medium-sized enterprises (including enterprises with abandoned/ suspended or on-going innovation activities), % of total number of enterprises in the population, Eurostat.

Indicator 2.21. Proportion of small companies engaged in innovative activities, percentage of all companies. Innovative small enterprises (including enterprises with abandoned/ suspended or ongoing innovation activities), % of total number of enterprises in the population, Eurostat.

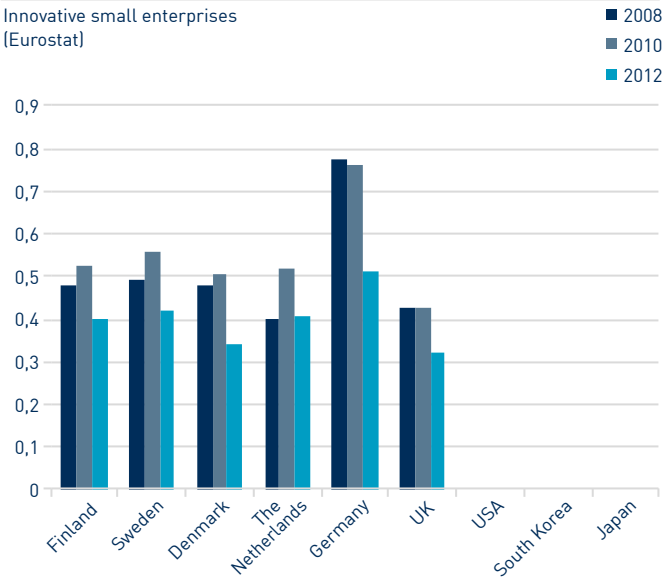
Indicator 2.22. Proportion of companies that have launched new products of small companies engaged in innovative activities, per cent.
Small enterprises that have introduced new or significantly improved products that were new to the market, % of small product innovative enterprises, Eurostat

Indicator 2.23. Proportion of companies that have launched new products of medium-sized companies engaged in innovative activities, percentage.
Medium-sized enterprises that have introduced new or significantly improved products that were new to the market, % of product innovative enterprises, Eurostat.

Indicator 2.24. Share of companies that have engaged in innovation cooperation of small companies engaged in innovative activities, percentage.
Innovation co-operation. Small enterprises (10–49 employees) having innovation co-operation, percentage of all small enterprises, Eurostat.

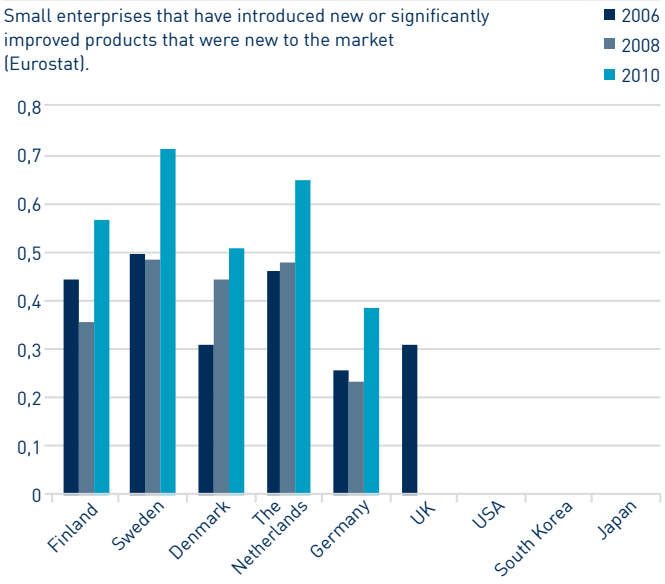
INDICATOR 2.21.

Innovative small enterprises
(Eurostat)



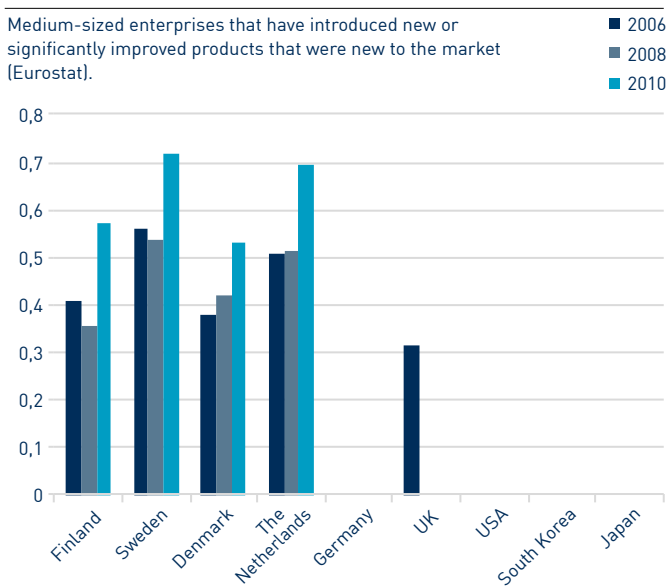
INDICATOR 2.22.

Small enterprises that have introduced new or significantly improved products that were new to the market
(Eurostat).



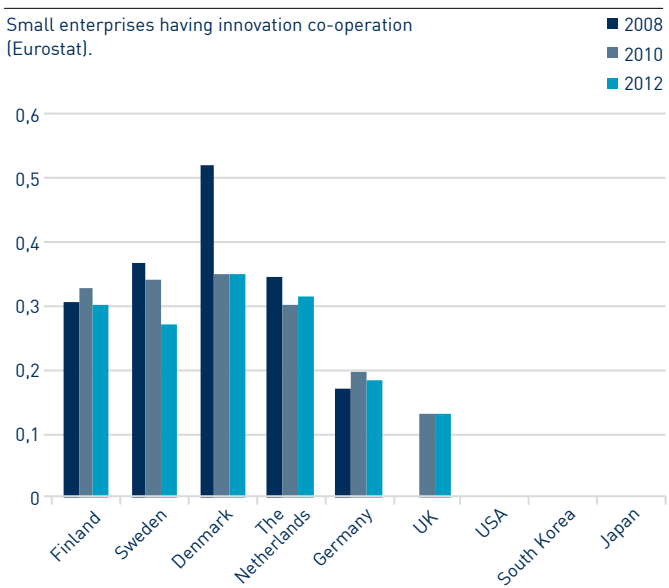
INDICATOR 2.23.

Medium-sized enterprises that have introduced new or significantly improved products that were new to the market
(Eurostat).



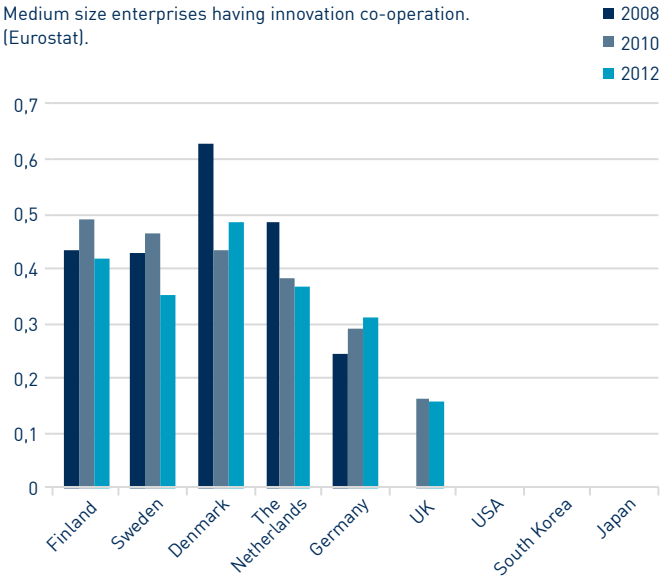
INDICATOR 2.24.

Small enterprises having innovation co-operation
(Eurostat).



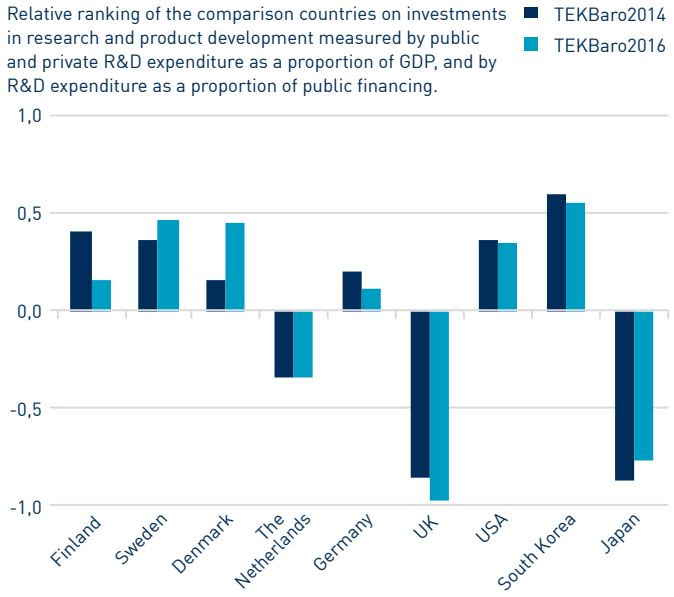
INDICATOR 2.25.

Medium size enterprises having innovation co-operation. (Eurostat).



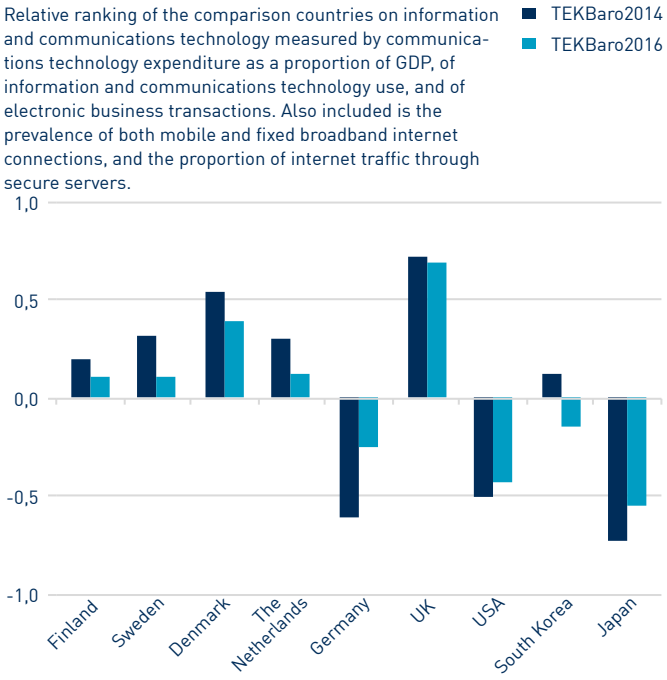
INDICATOR 2.26.

Relative ranking of the comparison countries on investments in research and product development measured by public and private R&D expenditure as a proportion of GDP, and by R&D expenditure as a proportion of public financing.



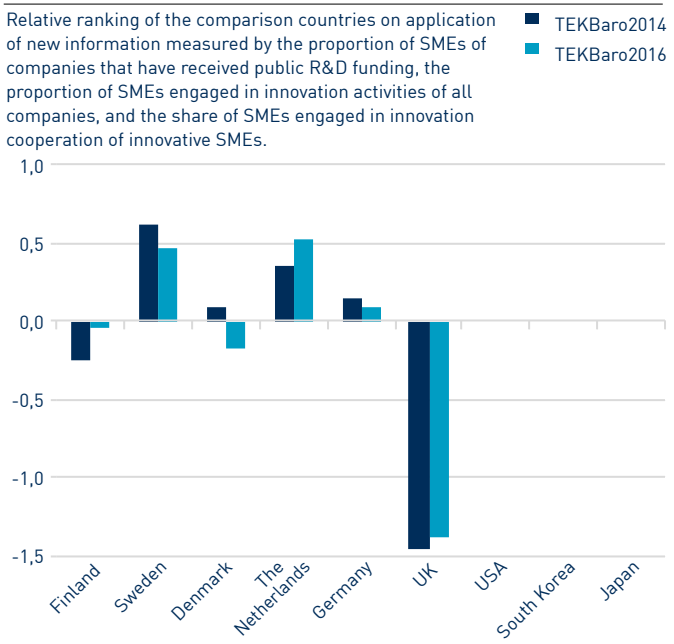
INDICATOR 2.27.

Relative ranking of the comparison countries on information and communications technology measured by communications technology expenditure as a proportion of GDP, of information and communications technology use, and of electronic business transactions. Also included is the prevalence of both mobile and fixed broadband internet connections, and the proportion of internet traffic through secure servers.



INDICATOR 2.28.

Relative ranking of the comparison countries on application of new information measured by the proportion of SMEs of companies that have received public R&D funding, the proportion of SMEs engaged in innovation activities of all companies, and the share of SMEs engaged in innovation cooperation of innovative SMEs.



Indicator 2.25. Share of companies that have engaged in innovation cooperation of medium-sized companies engaged in innovative activities, per cent. Innovation co-operation. Medium size enterprises (50–249 employees) having innovation co-operation, percentage of all medium size enterprises, Eurostat.

Combined indicators

Indicator 2.26. Relative ranking of the comparison countries on investments in research and product development measured by public and private R&D expenditure as a proportion of GDP, and by R&D expenditure as a proportion of public financing. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

Indicator 2.27. Relative ranking of the comparison countries on information and communications technology measured by communications technology expenditure as a proportion of GDP, of information and communications technology use, and of electronic business transactions. Also included is the prevalence of both mobile and fixed broadband internet connections, and the proportion of internet traffic through secure servers. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

Indicator 2.28. Relative ranking of the comparison countries on application of new information measured by the proportion of SMEs of companies that have received public R&D funding, the proportion of SMEs engaged in innovation activities of all companies, and the share of SMEs engaged in innovation cooperation of innovative SMEs. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

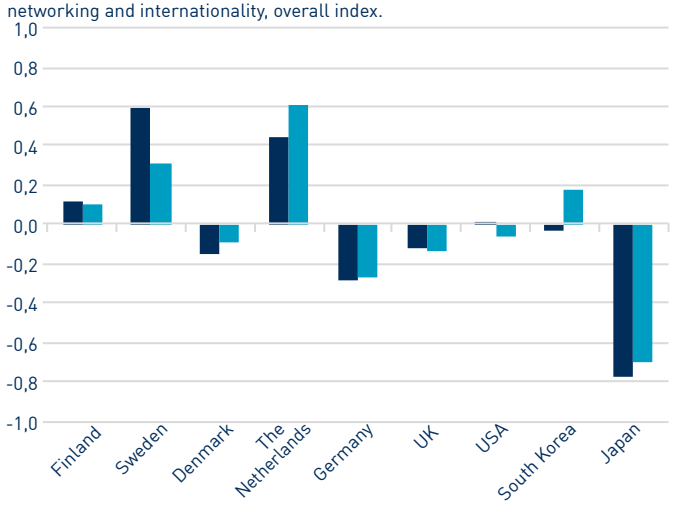
INNOVATIVE SOCIETY

Understanding of knowledge, knowledge management

Indicator 3.27. Relative ranking of the comparison countries on comprehension and management of information, entrepreneurship, regeneration of the economy, and networking and internationality according to the indices describing them. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

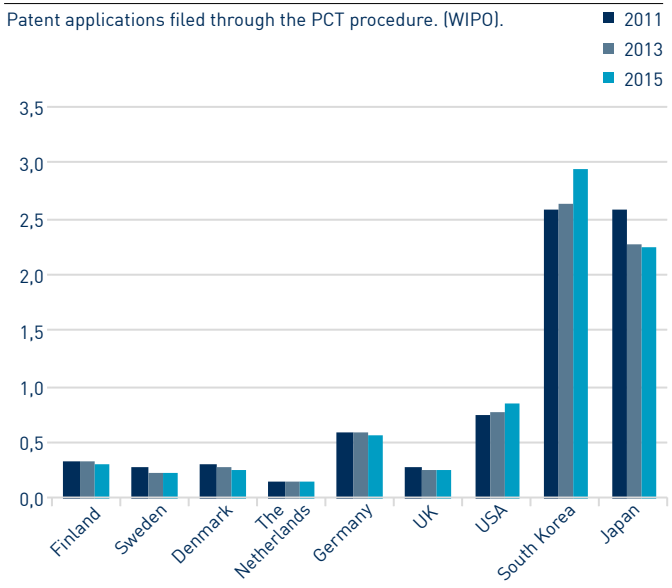
INDICATOR 3.27.

Relative ranking of the comparison countries on comprehension and management of information, entrepreneurship, regeneration of the economy, and networking and internationality, overall index.



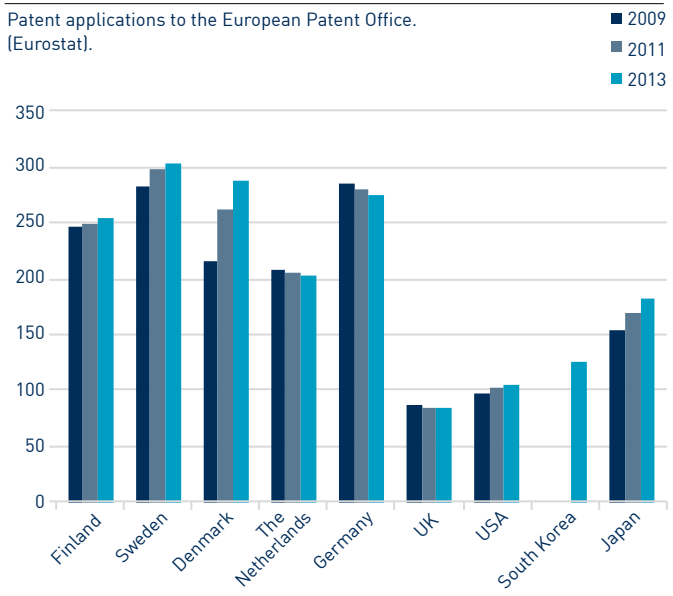
INDICATOR 3.1.

Patent applications filed through the PCT procedure. (WIPO).



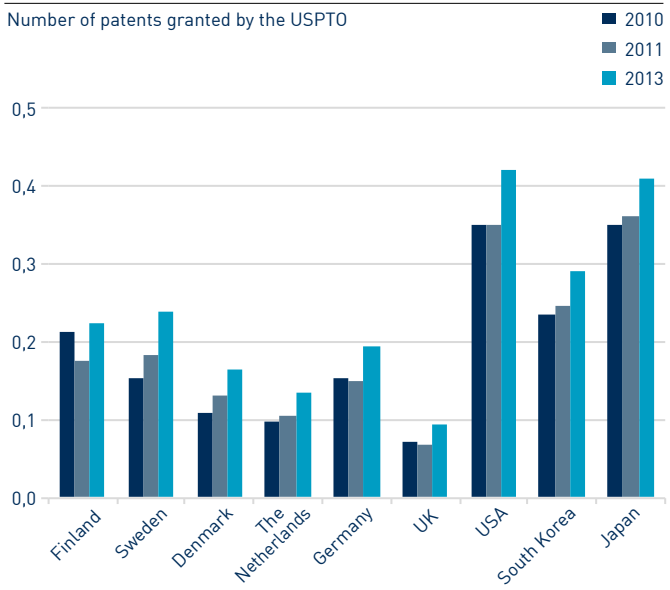
INDICATOR 3.2.

Patent applications to the European Patent Office. (Eurostat).



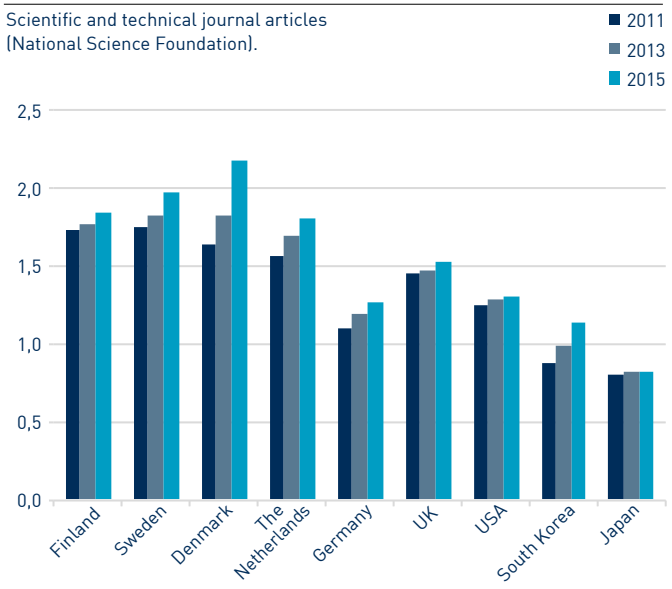
INDICATOR 3.3.

Number of patents granted by the USPTO



INDICATOR 3.4.

Scientific and technical journal articles (National Science Foundation).



Indicator 3.1. Patent applications submitted to PCT per one million inhabitants. Patent applications filed through the PCT procedure.
Patent applications are worldwide patent applications filed through the Patent Cooperation Treaty procedure or with a national patent office for exclusive rights for an invention - a product or process that provides a new way of doing something or offers a new technical solution to a problem. A patent provides protection for the invention to the owner of the patent for a limited period, generally 20 years. WIPO.

Indicator 3.2. Patent applications submitted to EPO per one million inhabitants. Patent applications to the European Patent Office, per million inhabitants. Data refer to applications filed directly under the European Patent Convention or to applications filed under the Patent Co-operation Treaty and designated to the EPO (Euro-PCT). Patent applications are counted according to the year in which they were filed at the EPO and are broken down according to the International Patent Classification (IPC). They are also broken down according to the inventor's place of residence, using fractional counting if multiple inventors or IPC classes are provided to avoid double counting. Eurostat.

Indicator 3.3. Patents granted by USPTO per one million inhabitants. Number of patents granted by the USPTO as distributed by year of patent grant, per 1000 people.

Indicator 3.4. Number of scientific articles per thousand inhabitants. Scientific and technical journal articles. Scientific and technical journal articles refer to the number of scientific and engineering articles published in the following fields: physics, biology, chemistry, mathematics, clinical medicine, biomedical research, engineering and technology, and earth and space sciences. National Science Foundation, Science and Engineering Indicators.

Indicator 3.5. Labour productivity (GDP per working hour) ESA2010.
Labour productivity per hour worked is calculated as real output (deflated GDP measured in chain-linked volumes, reference year 2010) per unit of labour input (measured by the total number of hours worked). Eurostat.

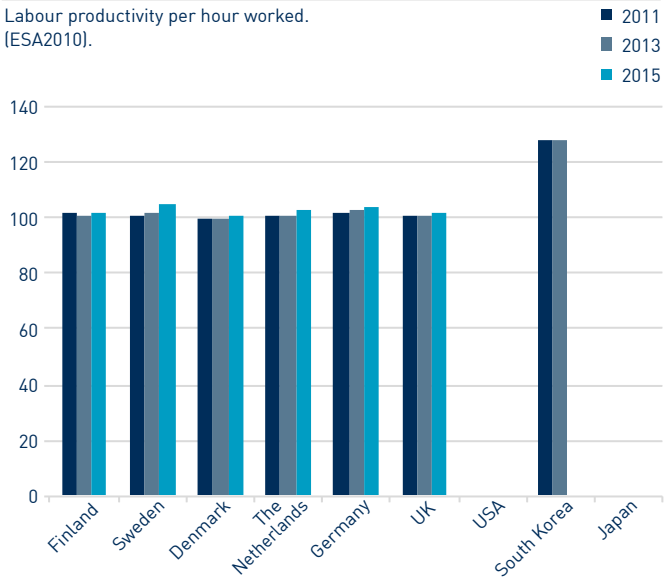
Indicator 3.6. Value of production in high-technology sectors percentage of GDP. Production value, high-technology manufacturing, % of GDP.
Manufacture of pharmaceuticals, medicinal chemicals and botanical products (NACE Rev 1.1: 24.4), office machinery and computers (NACE Rev 1.1: 30), radio, television and communication equipment and apparatus (NACE Rev 1.1: 32), medical, precision and optical instruments, watches and clocks (NACE Rev 1.1: 33) and aircraft and spacecraft (NACE Rev 1.1: 35.3). Eurostat.

Indicator 3.7. Value added by high- and mid-high technology sectors, as a percentage of GDP Value added at factor cost, high and medium high technology manufacturing, % of GDP. Eurostat.

Indicator 3.8. High-technology exports, percentage of total exports. Exports of high technology products as a proportion of total exports.
High-technology products are defined as the sum of the following products: Aerospace, computers, office machinery, electronics, instruments, pharmaceuticals, electrical machinery and armaments. The total exports for the EU do not include intra-EU trade. Eurostat.

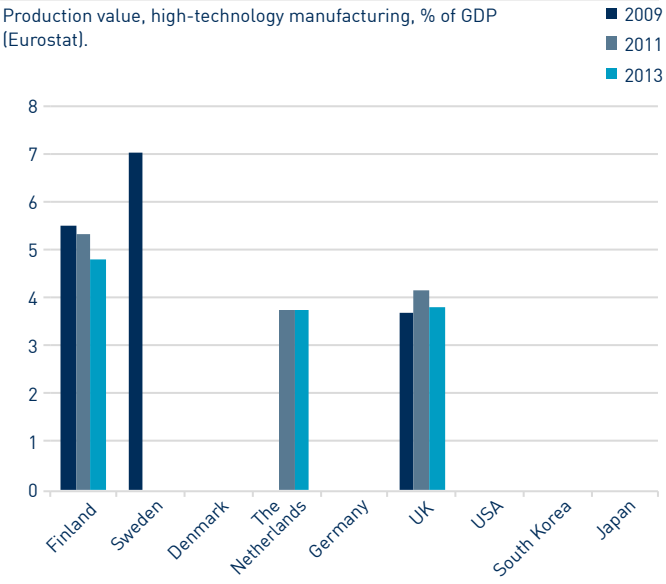
INDICATOR 3.5.

Labour productivity per hour worked.
(ESA2010).



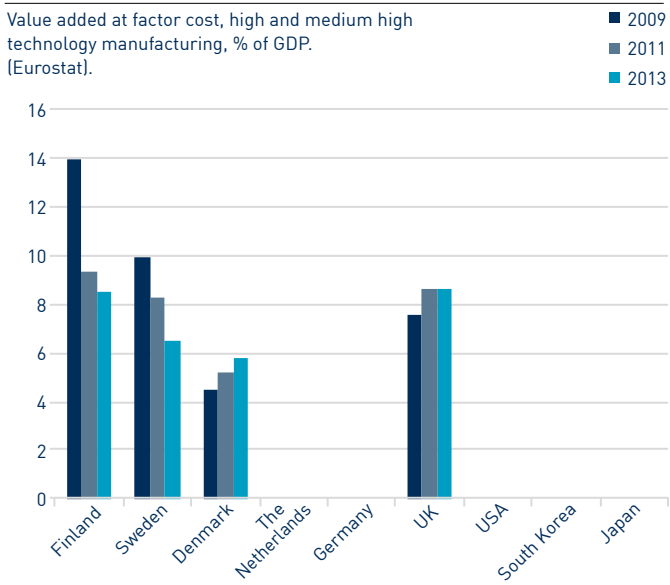
INDICATOR 3.6.

Production value, high-technology manufacturing, % of GDP
(Eurostat).



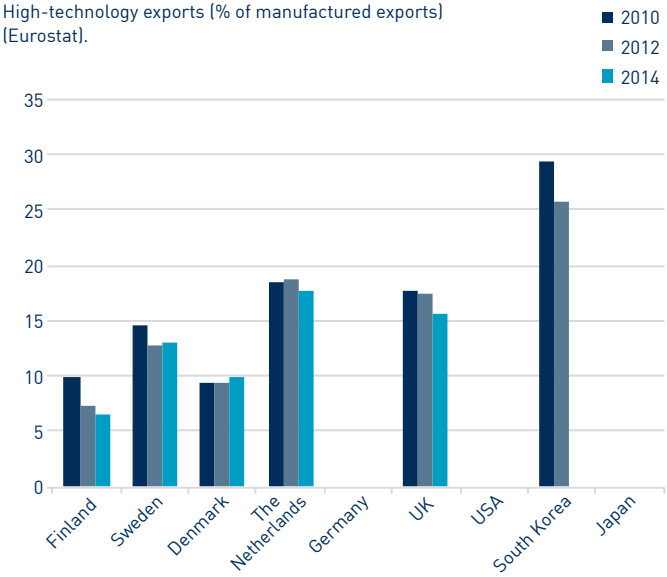
INDICATOR 3.7.

Value added at factor cost, high and medium high technology manufacturing, % of GDP.
(Eurostat).



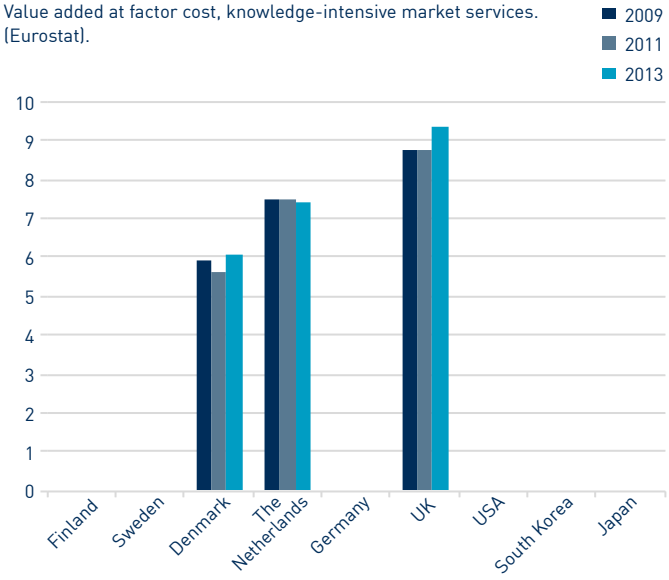
INDICATOR 3.8.

High-technology exports (% of manufactured exports)
(Eurostat).



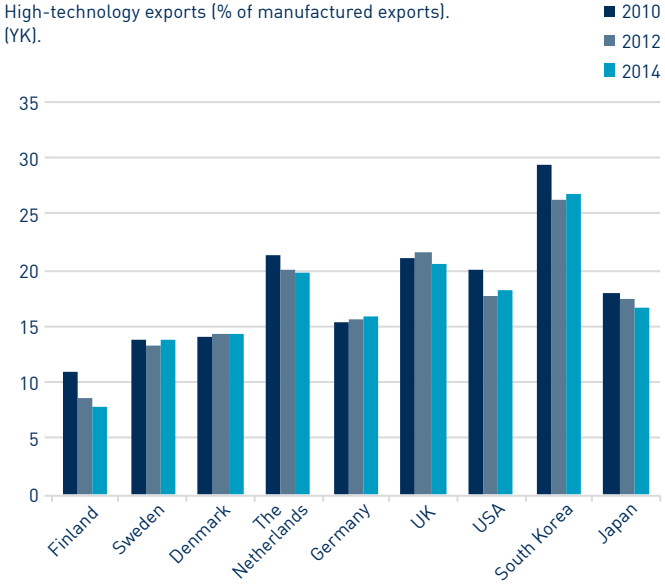
INDICATOR 3.9.

Value added at factor cost, knowledge-intensive market services. (Eurostat).



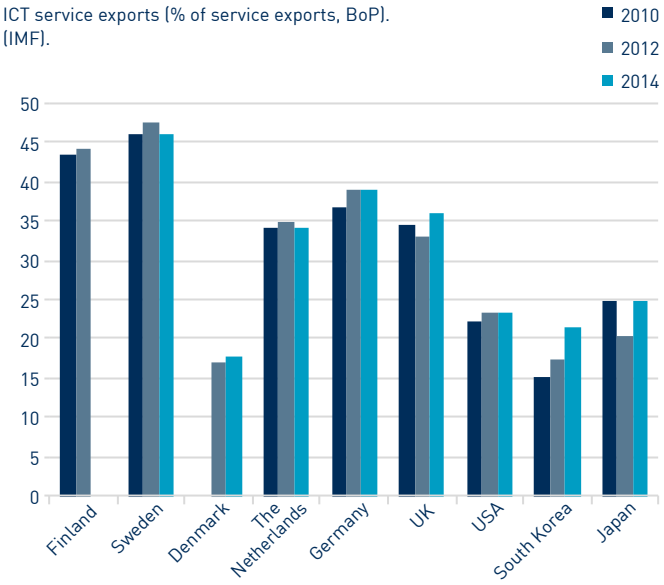
INDICATOR 3.10.

High-technology exports (% of manufactured exports). (YK).



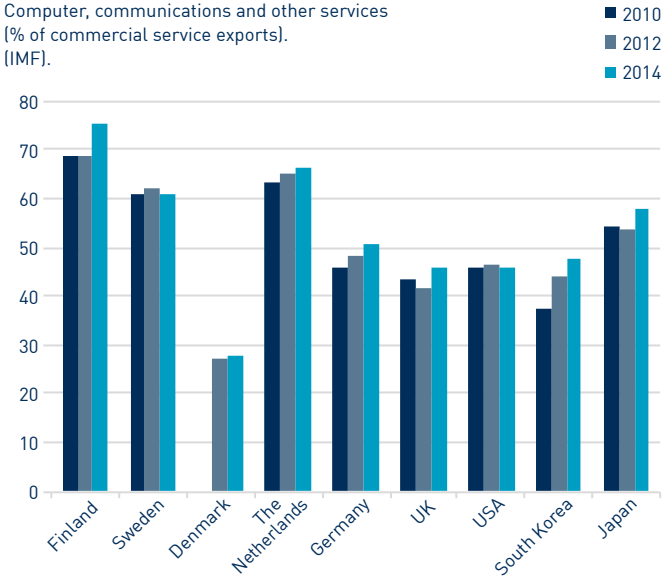
INDICATOR 3.11.

ICT service exports (% of service exports, BoP). (IMF).



INDICATOR 3.12.

Computer, communications and other services (% of commercial service exports). (IMF).



Indicator 3.9. Market-based competence-intensive services, value added, percentage of GDP. Value added at factor cost, knowledge-intensive market services (except financial intermediation and high-technology services), % of GDP. Eurostat.

Indicator 3.10. High-technology exports, percentage of industrial exports.
High-technology exports (% of manufactured exports). High-technology exports are products with high R&D intensity, such as in aerospace, computers, pharmaceuticals, scientific instruments, and electrical machinery. United Nations, Comtrade database.

Indicator 3.11. information and telecommunication technology services exports, extensive, percentage of export services. ICT service exports (% of service exports, BoP), Information and communication technology service exports include computer and communications services (telecommunications and postal and courier services) and information services (computer data and news-related service transactions). International Monetary Fund, Balance of Payments Statistics Yearbook and data files.

Indicator 3.12. information and telecommunication technology services exports, extensive, percentage of export services. Computer, communications and other services (% of commercial service exports). It includes such activities as international telecommunications, and postal and courier services; computer data; news-related service transactions between residents and non-residents; construction services; royalties and license fees; miscellaneous business, professional, and technical services; and personal, cultural, and recreational services. International Monetary Fund, Balance of Payments Statistics Yearbook and data files.

Entrepreneurship and regeneration

Indicator 3.13. Entrepreneurial activity, percentage of the adult population. Total Entrepreneurial Activity TEA, % trying to start or running a new business. The Total Entrepreneurial Activity rate (TEA) represents the sum of nascent (1) and new entrepreneurs (2) as a proportion of the adult population. The level of start-up activity is measured as the proportion of the adult population (16–64 years old) who are actively attempting to start a business, such persons are called nascent entrepreneurs. The new business prevalence rate is measured as the proportion of adult population who are currently active in running

a new business (a business that is no more than 42 months old). Those who reported both trying to start a new business and running a new business have been counted only once to obtain this measure. Global Entrepreneurship Monitor, GEM Global reports.

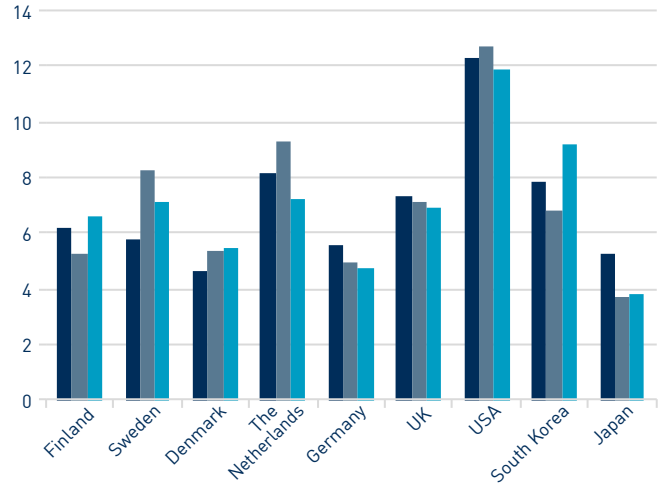
Indicator 3.14. Share of informal investors among the adult population, per cent. Prevalence of informal investors, % investing in other people's business. The prevalence rate of informal micro-investors is measured as the proportion of the adult population that has provided funding for start-up enterprises. The respondent had, in the past 3 years, personally provided funds for a new business started by someone else – publicly traded shares or mutual funds excluded. GEM 2003, 2010.Turku School of Economics.

Indicator 3.15. Share of beginning companies our of all companies, percentage. Business demography: birth rate of enterprises, % of the population of active enterprises. A birth amounts to the creation of a combination of production factors with the restriction that no other enterprises are involved in the event. Births do not include entries into the population due to mergers, break-ups, split-off or restructuring of a set of enterprises. It does not include entries into a sub-population resulting only from a change of activity. A birth occurs when an enterprise starts from scratch and actually starts activity. An enterprise creation can be considered an enterprise birth if new production factors, in particular new jobs, are created. If a dormant unit is reactivated within two years, this event is not considered a birth. Eurostat.

Indicator 3.16. Private sector investment rate, percentage. Gross fixed capital formation by the private sector as a percentage of GDP. Gross fixed capital formation (GFCF) consists of resident producers' acquisitions, less disposals of fixed assets plus certain additions to the value of non-produced (usually natural) assets realised by productive activity. GFCF includes acquisition less disposals of, e.g. buildings, structures, machinery and equipment, mineral exploration, computer software, literary or artistic originals and major improvements to land such as the clearance of forests. The private sector consists of non-financial corporations, financial corporations, households and non-profit organisations serving households. Eurostat.

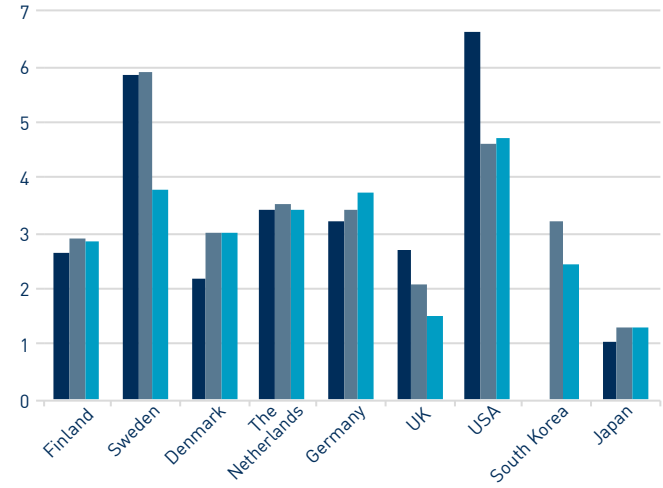
INDICATOR 3.13.

Total Entrepreneurial Activity TEA, % trying to start or running a new business. (Global Entrepreneurship Monitor)



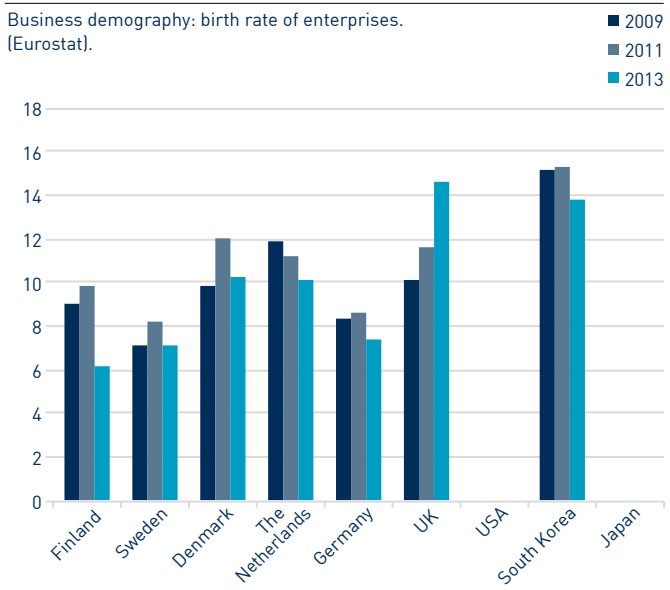
INDICATOR 3.14.

Business angel prevalence rate, % investing in other people's business. (Global Entrepreneurship Monitor).



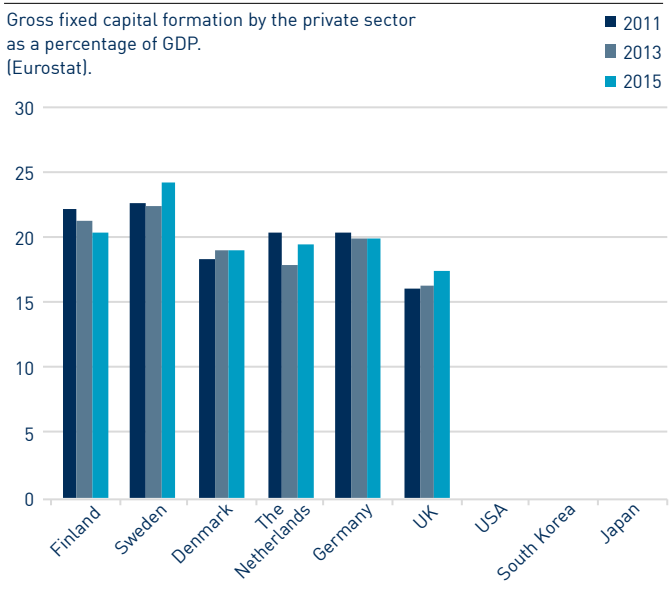
INDICATOR 3.15.

Business demography: birth rate of enterprises. (Eurostat).



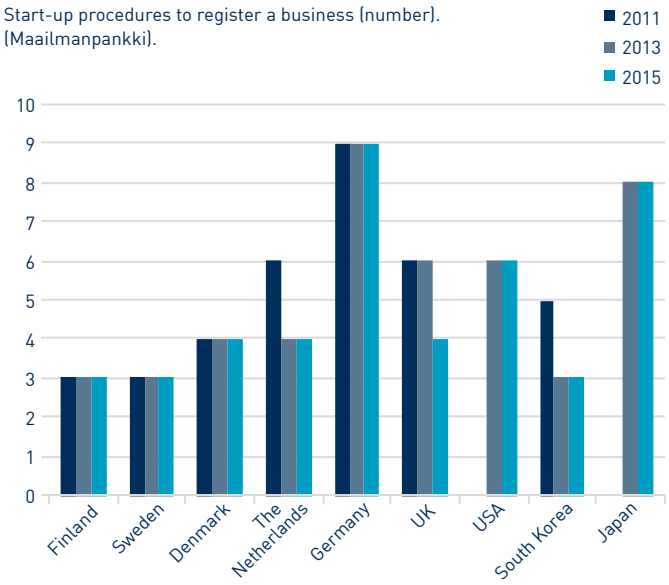
INDICATOR 3.16.

Gross fixed capital formation by the private sector as a percentage of GDP. (Eurostat).



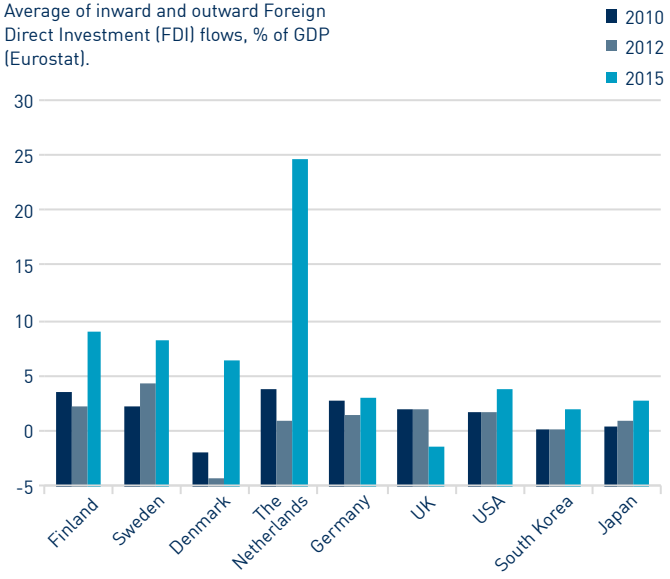
INDICATOR 3.17.

Start-up procedures to register a business (number). (Maailmanpankki).



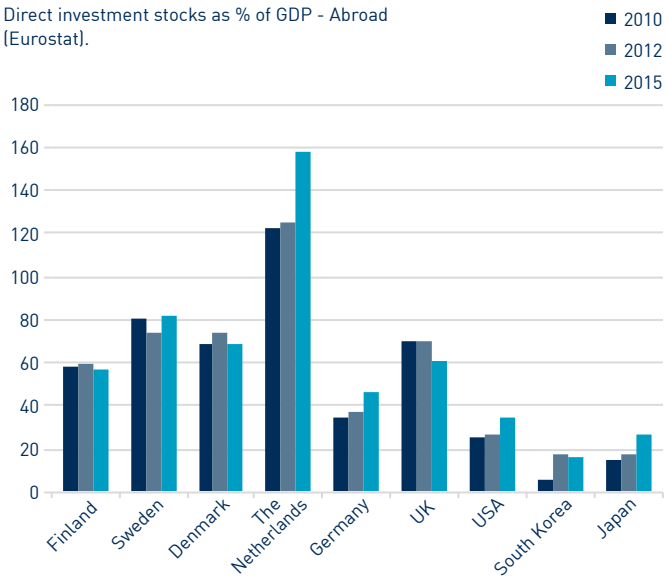
INDICATOR 3.18.

Average of inward and outward Foreign Direct Investment (FDI) flows, % of GDP (Eurostat).



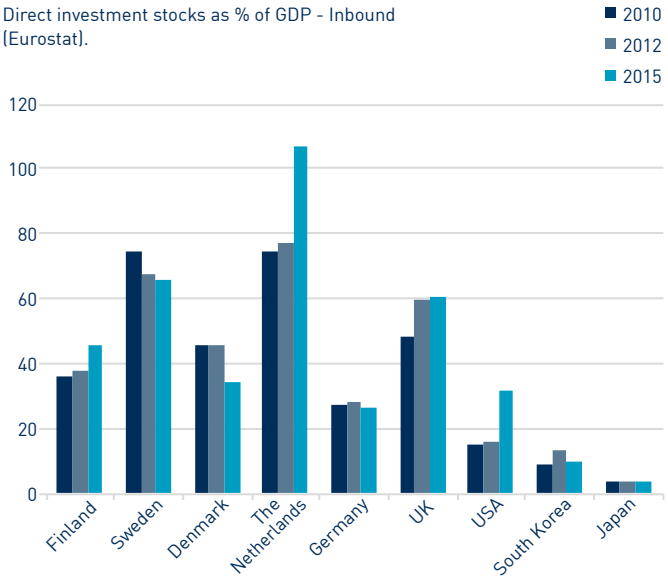
INDICATOR 3.19.

Direct investment stocks as % of GDP - Abroad (Eurostat).



INDICATOR 3.20.

Direct investment stocks as % of GDP - Inbound (Eurostat).



Indicator 3.17. New companies register necessary work amount. Start-up procedures to register a business (number). Start-up procedures are those required to start a business, including interactions to obtain necessary permits and licenses and to complete all inscriptions, verifications, and notifications to start operations. World Bank, Doing Business project (http://www.doingbusiness.org/).

Networking and internationality

Indicator 3.18. Share of inbound and outbound direct foreign investments of GDP, per cent. Average of inward and outward Foreign Direct Investment (FDI) flows, % of GDP. The index measures the intensity of investment integration within the international economy. The direct investment refers to the international investment made by a resident entity (direct investor) to acquire a lasting interest in an entity operating in an economy other than that of the investor (direct investment enterprise). Direct investment involves both the initial transactions between the two entities and all subsequent capital transactions between them and among affiliated enterprises, both incorporated and unincorporated. Eurostat.

Indicator 3.19. Share of outbound direct foreign investments of GDP, per cent. Direct investment stocks as % of GDP, abroad, total direct investment. Foreign direct investment (FDI) is the category of international investment made by a resident entity (direct investor) to acquire a lasting interest in an entity operating in an economy other than that of the investor (direct investment enterprise). The lasting interest is deemed to exist if the investor acquires at least 10% of the equity capital of the enterprise. FDI stocks are the value of FDI assets (for outward FDI stocks) and of FDI liabilities (for inward FDI stocks) at the end of the reference period. Eurostat.

Indicator 3.20. Share of inbound direct foreign investments of GDP, per cent. Direct investment stocks as % of GDP, inbound. Foreign direct investment (FDI) is the category of international investment made by a resident entity (direct investor) to acquire a lasting interest in an entity operating in an economy other than that of the investor (direct investment enterprise). The lasting interest is deemed to exist if the investor acquires at least 10% of the equity capital of the enterprise. FDI stocks are the value of FDI assets (for outward FDI stocks) and of FDI liabilities (for inward FDI stocks) at the end of the reference period. Eurostat.

Indicator 3.21. Share of foreign funding of companies' R&D expenditure, percentage of GDP. Business Enterprise Expenditure on R&D (BERD) financed by abroad as % of GDP. Research and experimental development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society and the use of this stock of knowledge to devise new applications (Frascati Manual, 2002 edition, § 63.). Eurostat.

Indicator 3.22. Openness to international trade: goods. Market integration by type of trade activities, average value of imports and exports of goods, % of GDP. If the index increases over time it means that the country/zone is becoming more integrated within the international economy. Eurostat.

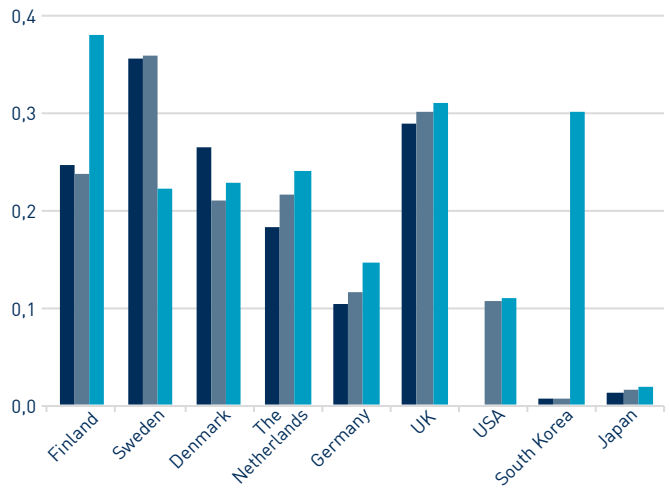
Indicator 3.23. Openness to international trade: services. Market integration by type of trade activities, average value of imports and exports of services, % of GDP. If the index increases over time it means that the country/zone is becoming more integrated within the international economy. Eurostat.

Combined indicators

Indicator 3.24. Relative ranking of the comparison countries on comprehension and management of information measured by the proportion of GDP that is accounted for by expenditure on patents and scientific articles, work productivity, manufacturing and export of advanced technology, information and telecommunication technology (ICT) services, and high- and medium-high-technology fields. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

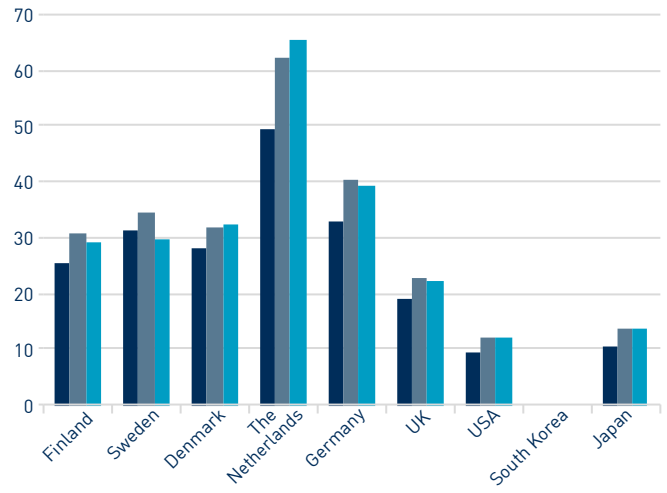
INDICATOR 3.21.

Business Enterprise Expenditure on R&D (BERD) financed by abroad as % of GDP (Eurostat).



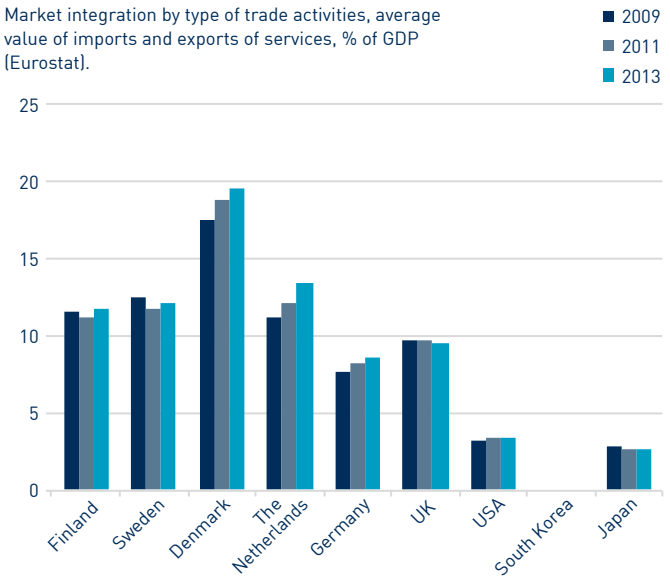
INDICATOR 3.22.

Market integration by type of trade activities, average value of imports and exports of goods, % of GDP (Eurostat).



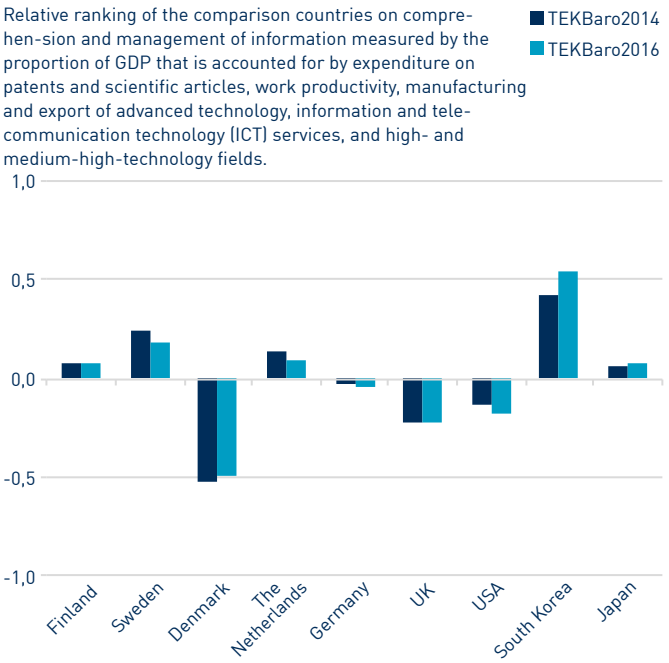
INDICATOR 3.23.

Market integration by type of trade activities, average value of imports and exports of services, % of GDP (Eurostat).



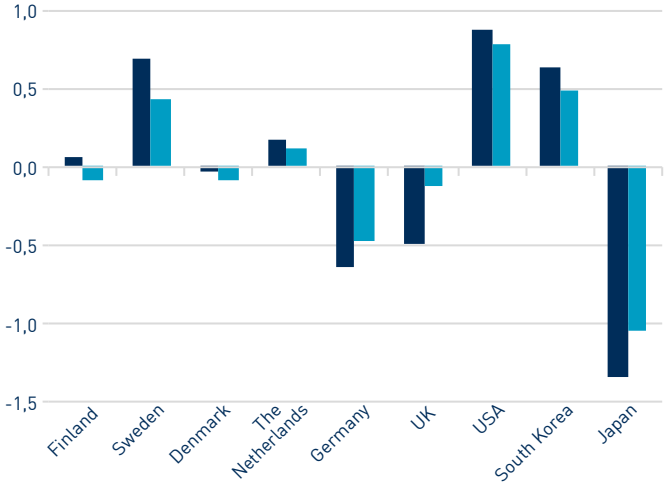
INDICATOR 3.24.

Relative ranking of the comparison countries on comprehen-sion and management of information measured by the proportion of GDP that is accounted for by expenditure on patents and scientific articles, work productivity, manufacturing and export of advanced technology, information and tele-communication technology (ICT) services, and high- and medium-high-technology fields.



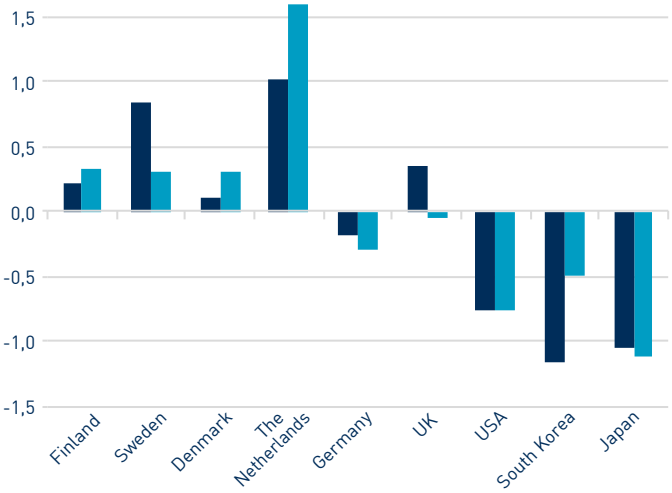
INDICATOR 3.25.

Relative ranking of the comparison countries on entrepreneurship and economic regeneration measured by the proportion of GDP accounted for by business capital investments, by the proportion of new businesses, the proportion of informal investors, and the degree of investment in the private sector.



INDICATOR 3.26.

Relative ranking of the comparison countries on networking and internationality measured by the proportion of GDP accounted for by foreign direct investments, the proportion of GDP accounted for by foreign financing in R&D in the business sector, and by the openness of trade.



Indicator 3.25. Relative ranking of the comparison countries on entrepreneurship and economic regeneration measured by the proportion of GDP accounted for by business capital investments, by the proportion of new businesses, the proportion of informal investors, and the degree of investment in the private sector. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

Indicator 3.26. Relative ranking of the comparison countries on networking and internationality measured as the proportion of GDP accounted for by foreign direct investments, by foreign funding of R&D in the business sector, and openness of trade. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

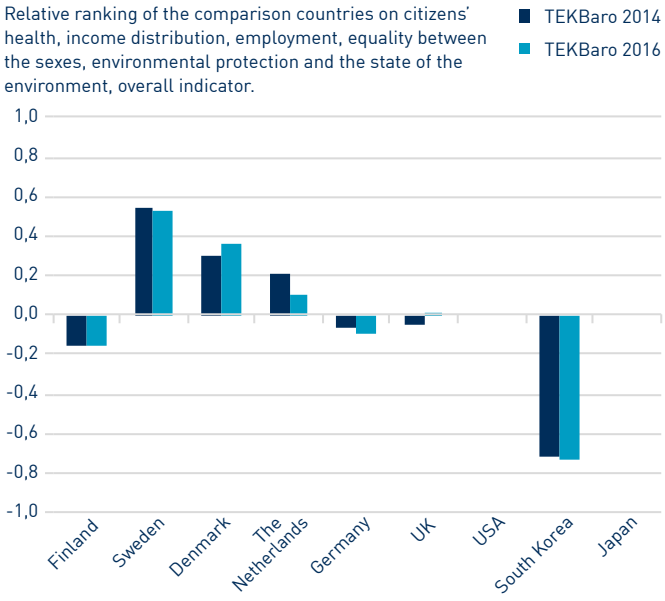
SUSTAINABLE DEVELOPMENT

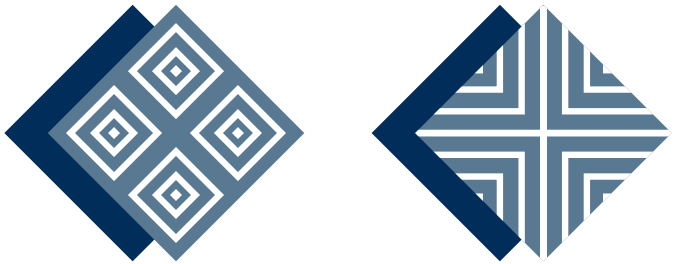
Social cohesion

Indicator 4.36. Relative ranking of the comparison countries on citizens' health, income distribution, employment, equality between the sexes, environmental protection and the state of the environment, overall indicator. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

INDICATOR 4.36.

Relative ranking of the comparison countries on citizens' health, income distribution, employment, equality between the sexes, environmental protection and the state of the environment, overall indicator.





Indicator 4.1. Life expectancy at birth, males. The mean number of years that a newborn child can expect to live if subjected throughout his life to the current mortality conditions (age specific probabilities of dying). Eurostat.

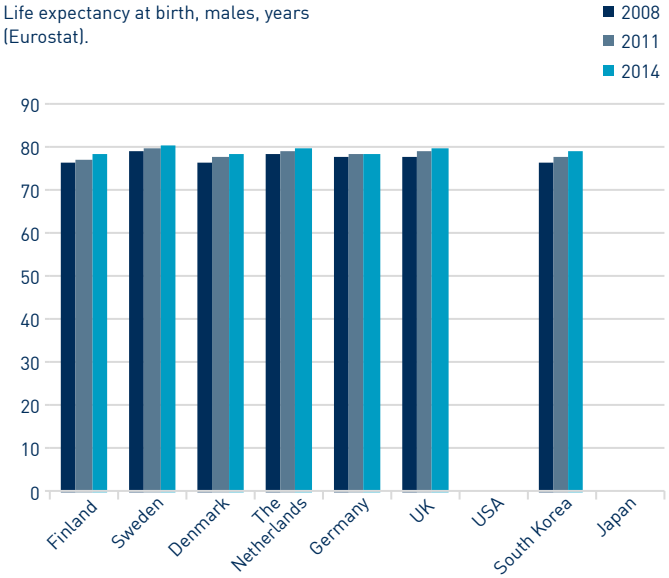
Indicator 4.2. Life expectancy in years, women. Life expectancy at birth – females.The mean number of years that a newborn child can expect to live if subjected throughout his life to the current mortality conditions (age specific probabilities of dying). Eurostat.

Indicator 4.3. Healthy life years at birth, males. It measures the number of years that a person at birth is still expected to live in a healthy condition. HLY is a health expectancy indicator which combines information on mortality and morbidity. The data required are the age-specific prevalence (proportions) of the population in healthy and unhealthy conditions and age-specific mortality information. A healthy condition is defined by the absence of limitations in functioning/disability. Eurostat.

Indicator 4.4. Healthy life years at birth, females. It measures the number of years that a person at birth is still expected to live in a healthy condition. HLY is a health expectancy indicator which combines information on mortality and morbidity. The data required are the age-specific prevalence (proportions) of the population in healthy and unhealthy conditions and age-specific mortality information. A healthy condition is defined by the absence of limitations in functioning/disability. Eurostat.

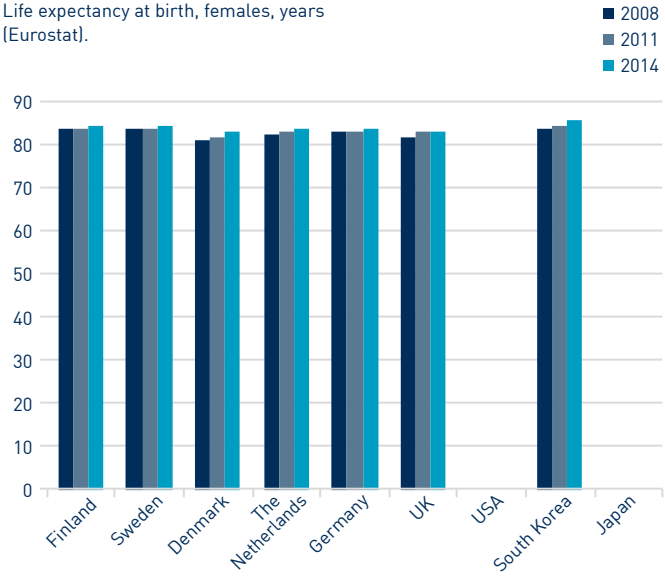
INDICATOR 4.1.

Life expectancy at birth, males, years (Eurostat).



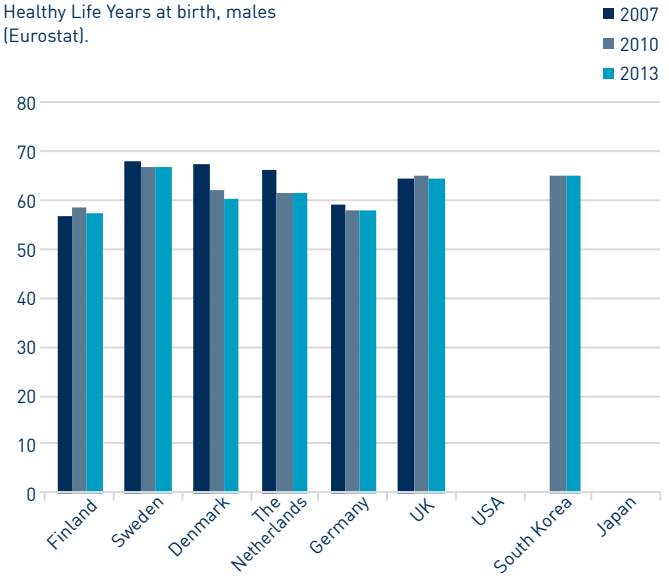
INDICATOR 4.2.

Life expectancy at birth, females, years (Eurostat).



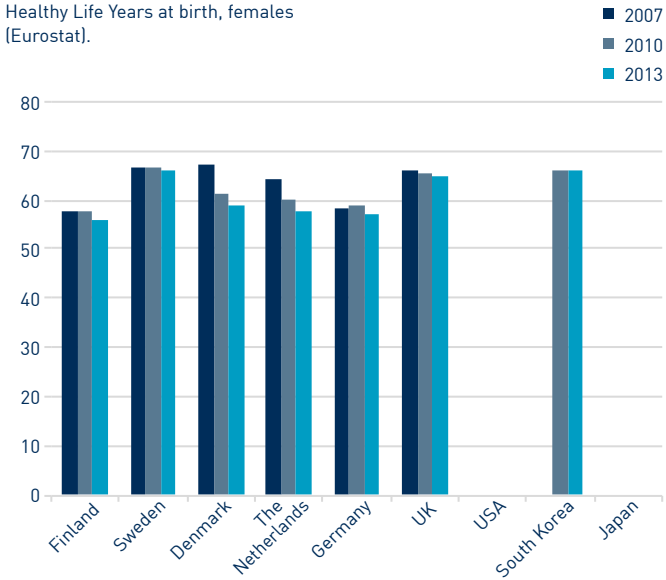
INDICATOR 4.3.

Healthy Life Years at birth, males (Eurostat).



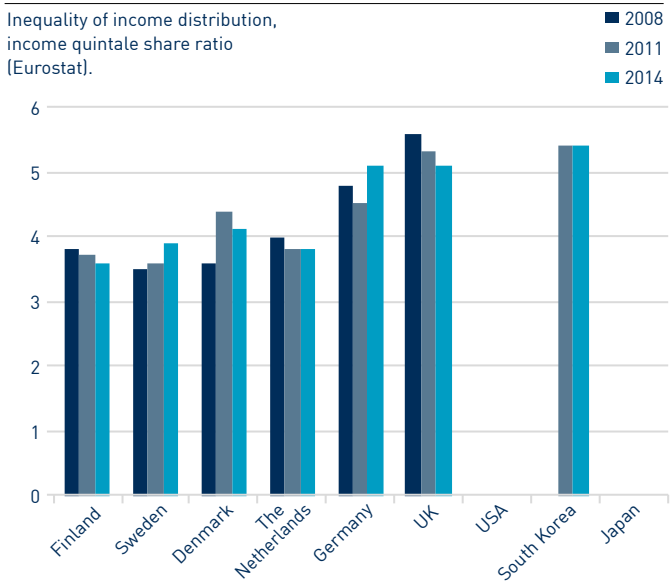
INDICATOR 4.4.

Healthy Life Years at birth, females (Eurostat).



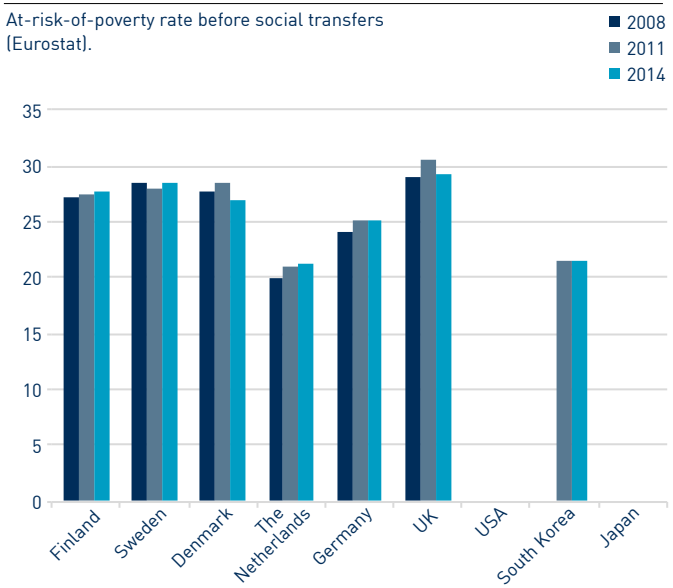
INDICATOR 4.5.

Inequality of income distribution, income quintale share ratio (Eurostat).



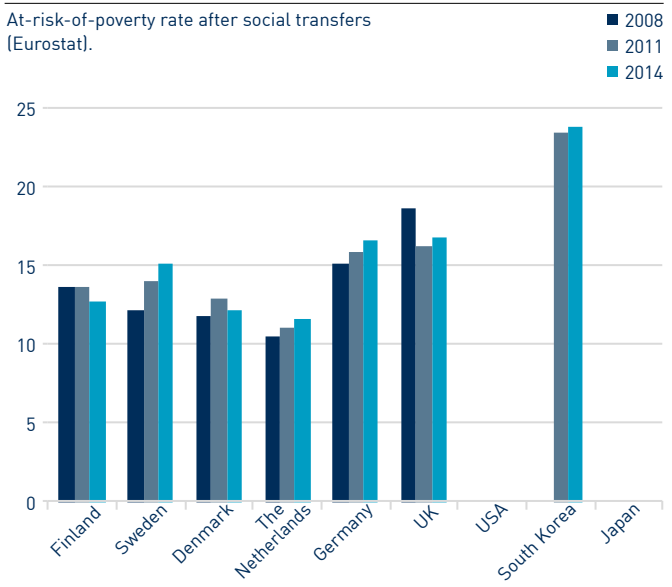
INDICATOR 4.6.

At-risk-of-poverty rate before social transfers (Eurostat).



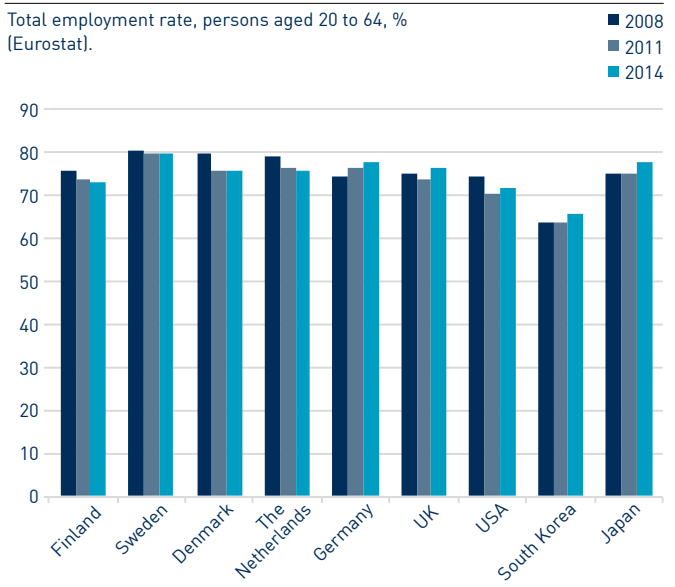
INDICATOR 4.7.

At-risk-of-poverty rate after social transfers (Eurostat).



INDICATOR 4.8.

Total employment rate, persons aged 20 to 64, % (Eurostat).



Income distribution

Indicator 4.5. Income distribution ratio.
Inequality of income distribution, income quantile share ratio. The ratio of total income received by the 20% of the population with the highest income (top quintile) to that received by the 20% of the population with the lowest income (lowest quintile). Income must be understood as equalised disposable income. Eurostat.

Indicator 4.6. Poverty risk prior to social income transfers, percentage.
At-risk-of-poverty rate before social transfers. The share of persons with an equalised disposable income, before social transfers, below the at-risk-of-poverty threshold. Retirement and survivor's pensions are counted as income before transfers and not as social transfers. Retirement and survivor's pensions are counted as income before transfers and not as social transfers. Eurostat.

Indicator 4.7. Poverty risk after social income transfers, percentage.
At-risk-of-poverty rate after social transfers. The share of persons with an equalised disposable income below the risk-of-poverty threshold, which is set at 60% of the national median equalised disposable income (after social transfers). Eurostat.

Employment situation

Indicator 4.8. Employment rate, percentage of those aged 15–64. Total employment rate, persons aged 20 to 64, %. The employment rate is calculated by dividing the number of persons aged 20 to 64 in employment by the total population of the same age group. The indicator is based on the EU Labour Force Survey. The survey covers the entire population living in private households and excludes those in collective households such as boarding houses, halls of residence and hospitals. Employed population consists of those persons who during the reference week did any work for pay or profit for at least one hour, or were not working but had jobs from which they were temporarily absent. Eurostat.

Indicator 4.9. Employment rate among ageing people, percentage of those aged 55–64.
The employment rate of older workers is calculated by dividing the number of persons aged 55 to 64 in employment by the total population of the same age group. The indicator is based on the EU Labour Force Survey. Eurostat.

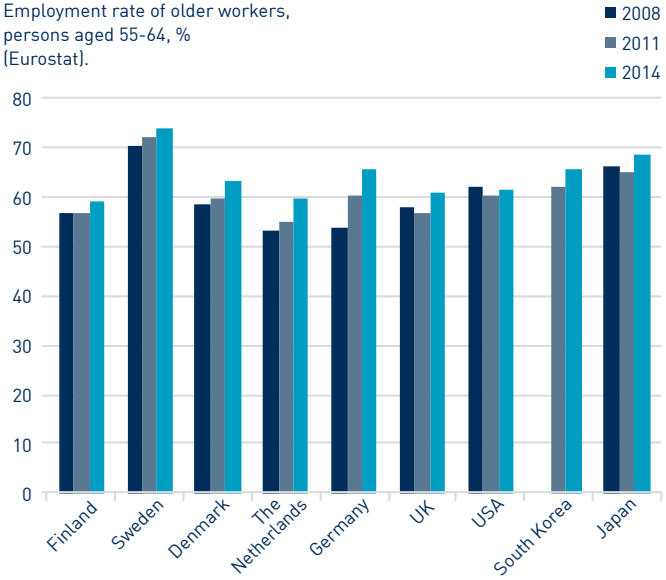
Indicator 4.10. Unemployment rate, per cent.
Employment rate of older workers, persons aged 55–64, %. The employment rate of older workers is calculated by dividing the number of persons in employment and aged 55 to 64 by the total population of the same age group. The indicator is based on the EU Labour Force Survey. The survey covers the entire population living in private households and excludes those in collective households such as boarding houses, halls of residence and hospitals. Employed population consists of those persons who during the reference week did any work for pay or profit for at least one hour, or were not working but had jobs from which they were temporarily absent. Eurostat.

Indicator 4.11. Share of young unemployed, per cent.
Unemployment rate by sex and age groups - annual average, persons aged less than 25 years, %.
Not seasonally adjusted data. Eurostat.

Indicator 4.12. Share of long-term unemployed, per cent. Long-term unemployment - annual average, % of active population. Long-term unemployed (12 months and more) persons are those aged at least 15 years not living in collective households who are without work within the next two weeks, are available to start work within the next two weeks and who are seeking work (have actively sought employment at some time during the previous four weeks or are not seeking a job because they have already found a job to start later). The total active population (labour force) is the total number of the employed and unemployed population. Eurostat.

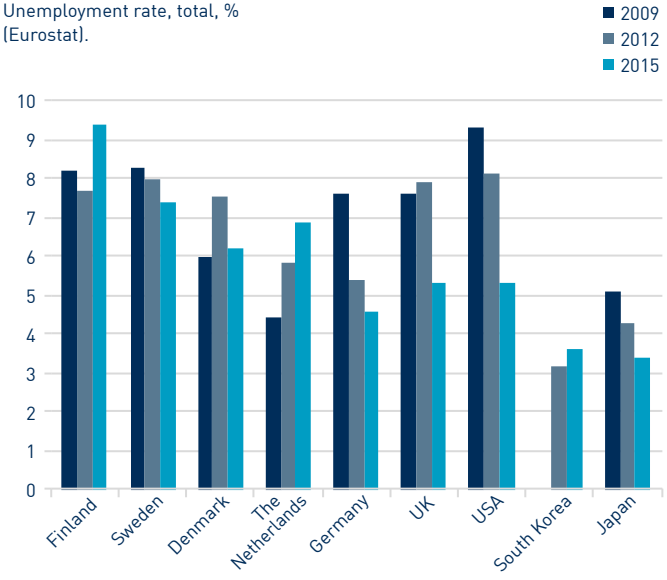
INDICATOR 4.9.

Employment rate of older workers, persons aged 55-64, % (Eurostat).



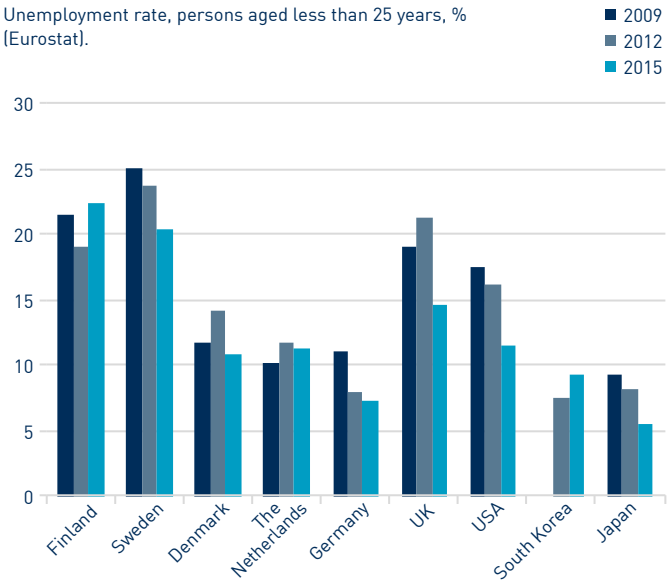
INDICATOR 4.10.

Unemployment rate, total, % (Eurostat).



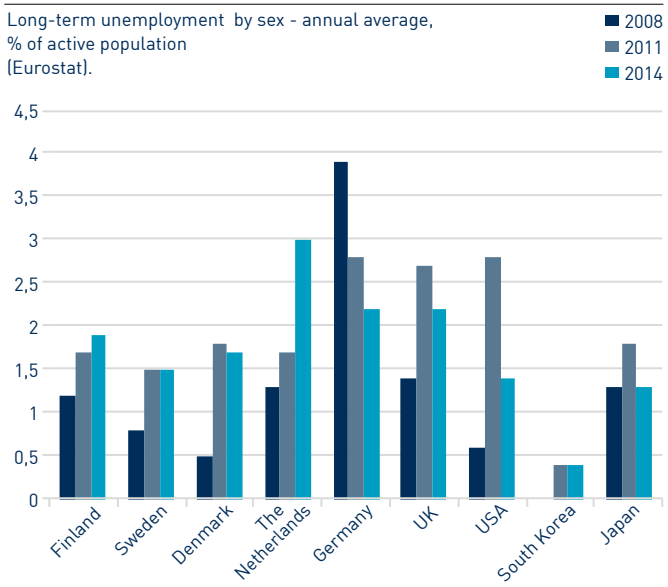
INDICATOR 4.11.

Unemployment rate, persons aged less than 25 years, % (Eurostat).



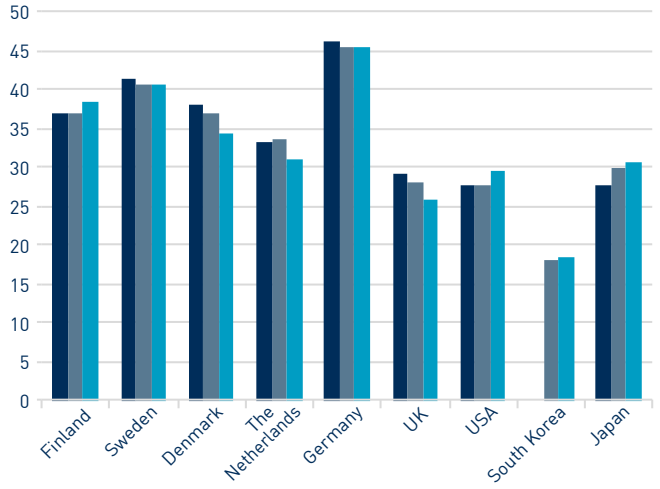
INDICATOR 4.12.

Long-term unemployment by sex - annual average, % of active population (Eurostat).



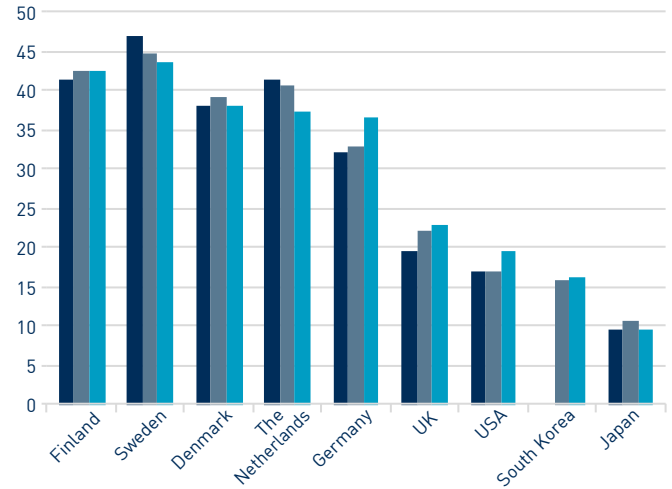
INDICATOR 4.13.

Tax rate on low wage earners: tax wedge on labour costs (Eurostat).



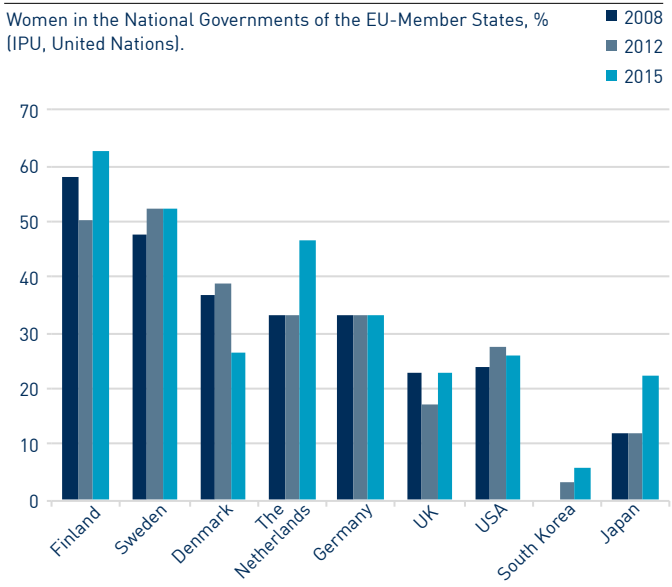
INDICATOR 4.14.

Seats held by women in national parliament, % (United Nations).



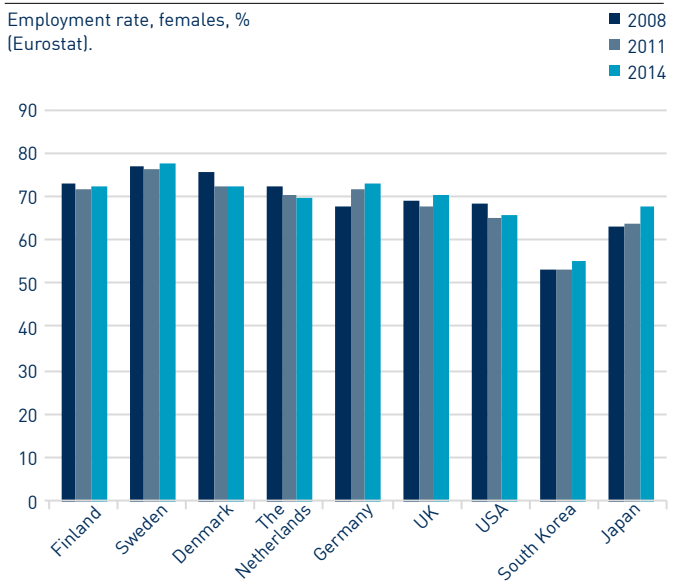
INDIKAATTORI 4.15.

Women in the National Governments of the EU-Member States, % (IPU, United Nations).



INDICATOR 4.16.

Employment rate, females, % (Eurostat).



Indicator 4.13. Earned income tax rate, per cent.
Tax rate on low wage earners: tax wedge on labour costs, %. The tax wedge on the labour cost measures the relative tax burden for an employed person with low earnings. Eurostat.

Equality between the sexes

Indicator 4.14. Percentage of female members of parliament.
Seats held by women in national parliament, %. United Nations Statistics Division. Millenium Development Goals Indicators (MDG).

Indicator 4.15. Percentage of female representation in national cabinets.
Women in ministerial positions. http://www.ipu.org/pdf/publications/wmnmap15_en.pdf, IPU / UN.

Indicator 4.16. Female employment rate, percentage.
Employment rate, females, %. The female employment rate is calculated by dividing the number of women aged 15 to 64 in employment by the total female population of the same age group. The indicator is based on the EU Labour Force Survey. Employed population consists of those persons who during the reference week did any work for pay or profit for at least one hour, or were not working but had jobs from which they were temporarily absent. Eurostat.

Indicator 4.17. Salary differences between the sexes, percentage of the average hourly wage for males. Gender pay gap in unadjusted form, %. Gender pay gap is given as the difference between the average gross hourly earnings of male paid employees and of female paid employees as a percentage of average gross hourly earnings of male paid employees. The population consists of all paid employees aged 16–64 that are at work 15+ hours per week. Eurostat.

Environmental protection

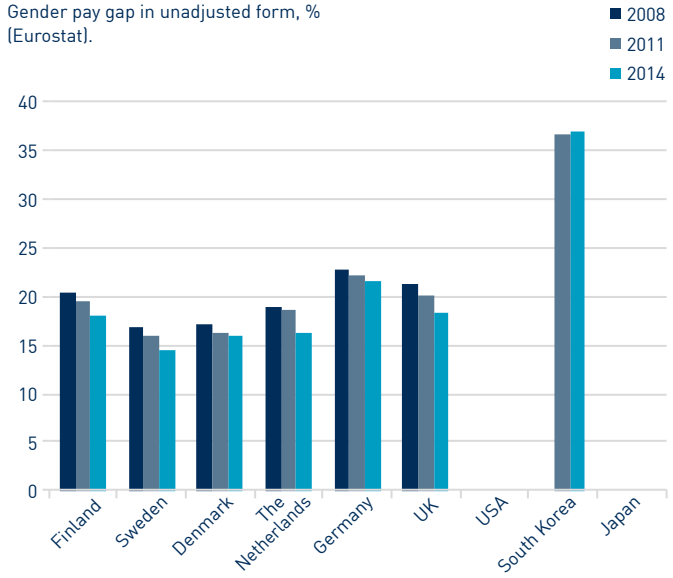
Indicator 4.18. Investments in environmental protection, euros per person. Environmental protection expenditure in Europe - indicators: total industry plus public sector, euros per person. Total environmental protection activities. Environmental protection expenditure includes all activities directly aimed at the prevention, reduction and elimination of pollution or any other degradation of the environment. Eurostat.

Indicator 4.19. Investments in environmental protection, percentage of GDP. Environmental protection expenditure in Europe - indicators: total industry plus public sector, percentage of GDP. Environmental expenditure means how much has been spent to protect the environment. It includes both investments and current expenditure. Eurostat.

Indicator 4.20. Amount of greenhouse gas emissions per inhabitant. Greenhouse gas emissions, 1000 tonnes of CO2 equivalent, per inhabitant. European Environment Agency (EEA). Eurostat.

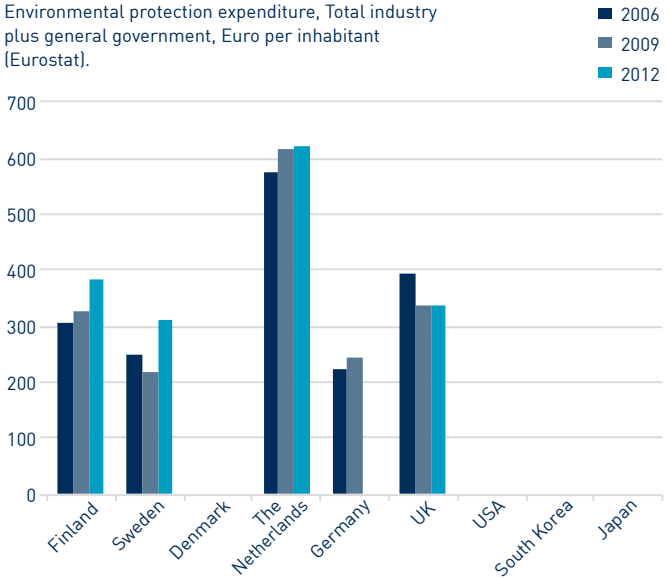
INDICATOR 4.17.

Gender pay gap in unadjusted form, % (Eurostat).



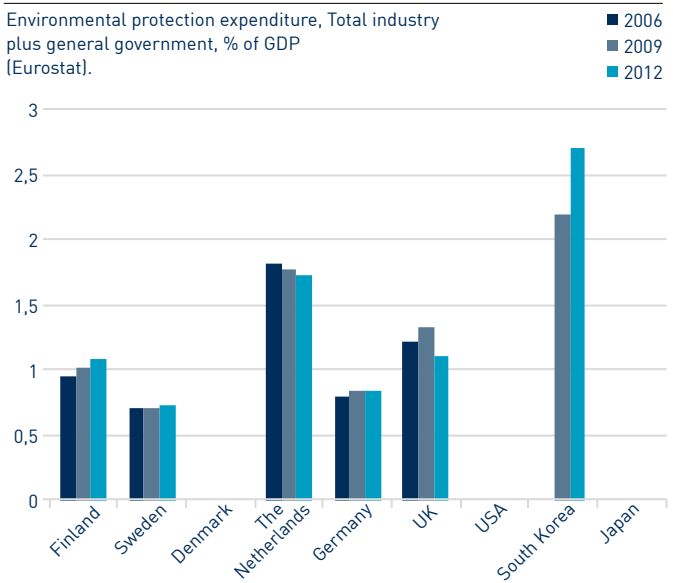
INDICATOR 4.18.

Environmental protection expenditure, Total industry plus general government, Euro per inhabitant (Eurostat).



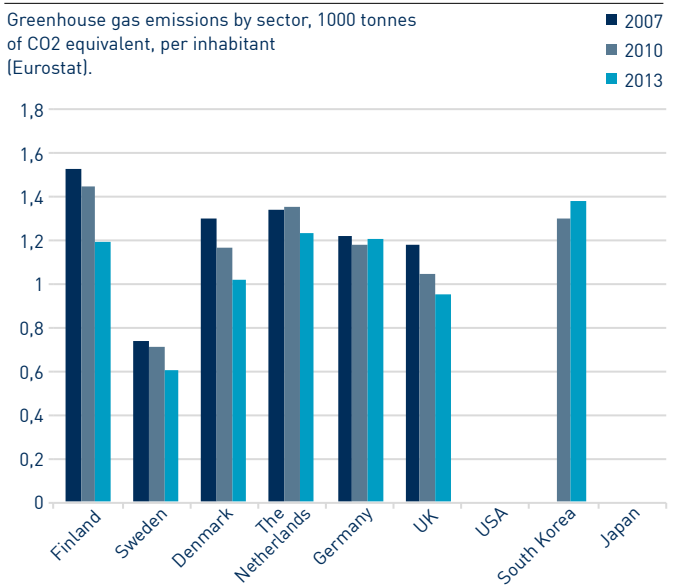
INDICATOR 4.19.

Environmental protection expenditure, Total industry plus general government, % of GDP (Eurostat).



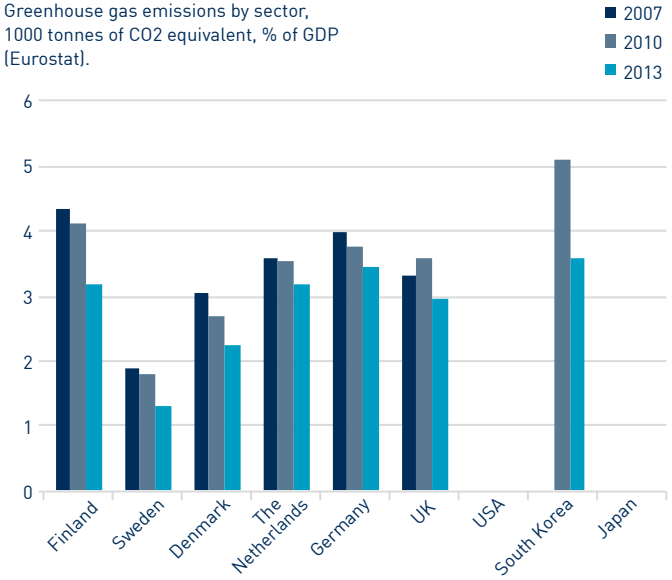
INDICATOR 4.20.

Greenhouse gas emissions by sector, 1000 tonnes of CO2 equivalent, per inhabitant (Eurostat).



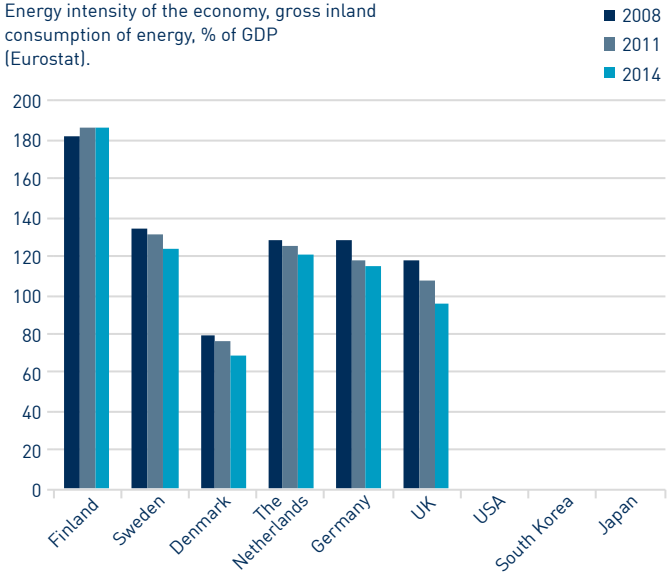
INDICATOR 4.21.

Greenhouse gas emissions by sector, 1000 tonnes of CO2 equivalent, % of GDP (Eurostat).



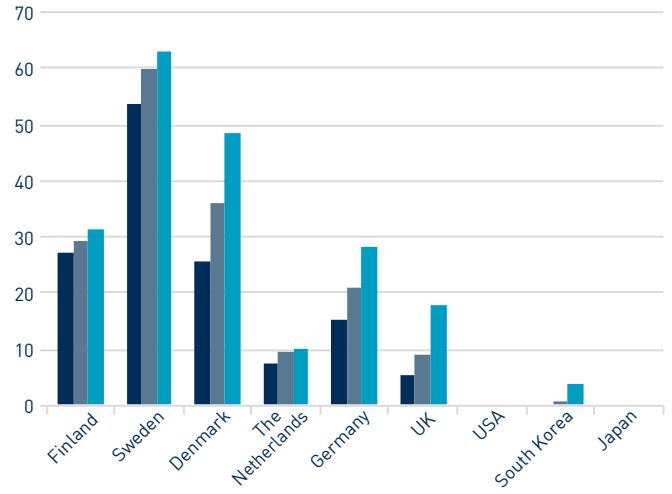
INDICATOR 4.22.

Energy intensity of the economy, gross inland consumption of energy, % of GDP (Eurostat).



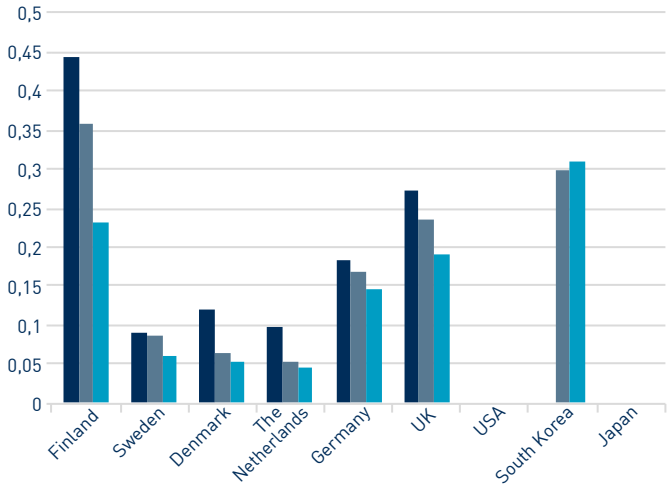
INDICATOR 4.23.

Electricity generated from renewable sources - % of gross electricity consumption (Eurostat).



INDICATOR 4.24.

Sulphur oxides intensities, SOx emission intensities, % of GDP. (Eurostat).



Indicator 4.21. Greenhouse gas emissions percentage of GDP. Greenhouse gas emissions, 1000 tonnes of CO2 equivalent, percentage of GDP. European Environment Agency (EEA), Eurostat.

Indicator 4.22. Energy intensity, overall consumption of energy sources relative to gross domestic product. Electricity generated from renewable sources - % of gross electricity consumption. This indicator is the ratio between the electricity produced from renewable energy sources and the gross national electricity consumption for a given calendar year. It measures the contribution of electricity produced from renewable energy sources to the national electricity consumption. Electricity produced from renewable energy sources comprises the electricity generation from hydro plants (excluding pumping), wind, solar, geothermal and electricity from biomass/wastes. Gross national electricity consumption comprises the total gross national electricity generation from all fuels (including vehicle production), plus electricity imports, minus exports. Eurostat.

Indicator 4.23. Proportion of overall energy production accounted for by renewable energy sources. Electricity generated from renewable sources - % of gross electricity consumption. This indicator is the ratio between the electricity produced from renewable energy sources and the gross national electricity consumption for a given calendar year. It measures the contribution of electricity produced from renewable energy sources to the national electricity consumption. Electricity produced from renewable energy sources comprises the electricity generation from hydro plants (excluding pumping), wind, solar, geothermal and electricity from biomass/wastes. Gross national electricity consumption comprises the total gross national electricity generation from all fuels (including vehicle production), plus electricity imports, minus exports. Eurostat.

State of the environment

Indicator 4.24. Sulphur dioxide emissions relative to gross domestic product. Sulphur oxide intensities, SOx emission intensities, % of GDP. European Environment Agency (EEA), Eurostat.

Indicator 4.25. Sulphur dioxide emissions relative to gross domestic product.
Nitrogen oxides emissions, NOx emission intensities, % of GDP. European Environment Agency (EEA). Eurostat.

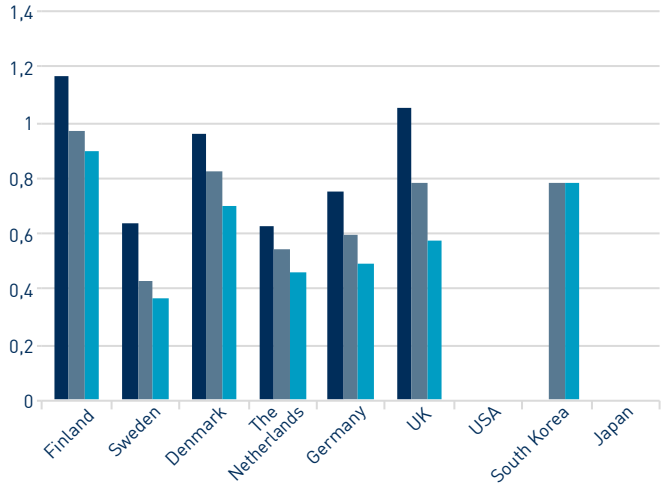
Indicator 4.26. Emissions of volcanic organic compounds relative to gross domestic product.
Non-methane volatile organic compounds (NMVOC), total sectors of emissions for the national territory, % of GDP, European Environment Agency (EEA). Eurostat.

Indicator 4.27. The threats posed to human health by air- and waterborne impurities.
Risk of water and air pollution to human health. ERE describes actual health outcomes, complementing the EPI's Air Quality and Water indicators, which characterise the factors that drive these health effects rather than the outcomes themselves. Environmental Performance Index (Yale Center for Environmental Law & Policy).

Indicator 4.28. Exposure to microscopic particles in the atmosphere and the associated health risk.
Population weighted exposure to PM2.5 (three- year average). Air Pollution: Average Exposure to PM2.5. Environmental Performance Index (Yale Center for Environmental Law & Policy).

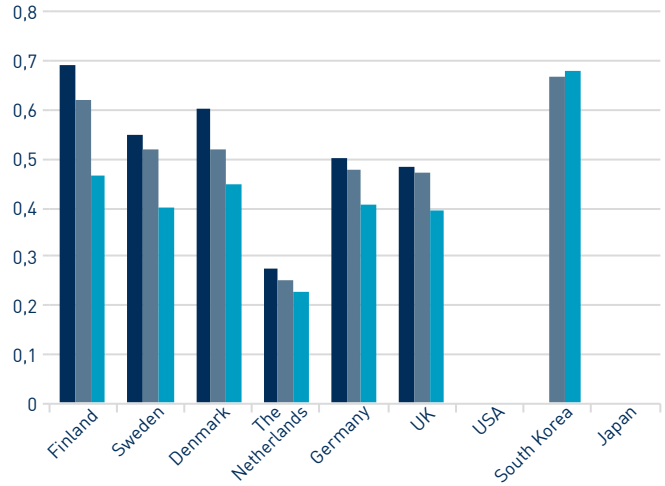
INDICATOR 4.25.

Nitrogen oxides emissions, NOx emission intensities, % of GDP. (Eurostat).



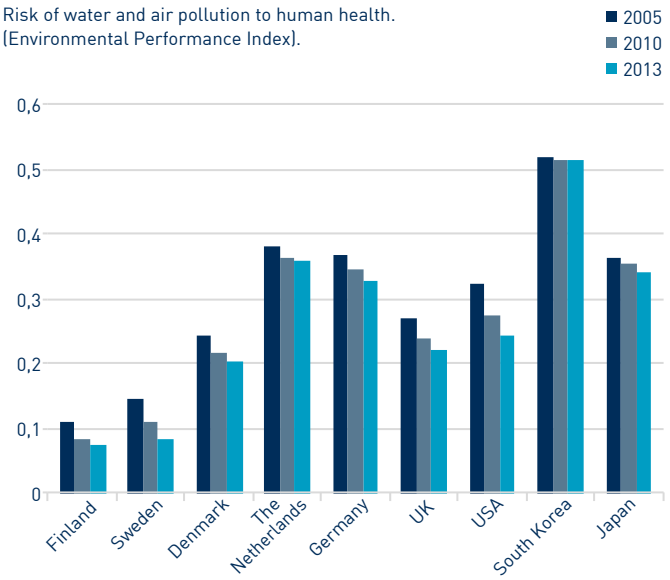
INDICATOR 4.26.

Non-methane volatile organic compounds (NMVOC), total sectors of emissions for the national territory, % of GDP (Eurostat).



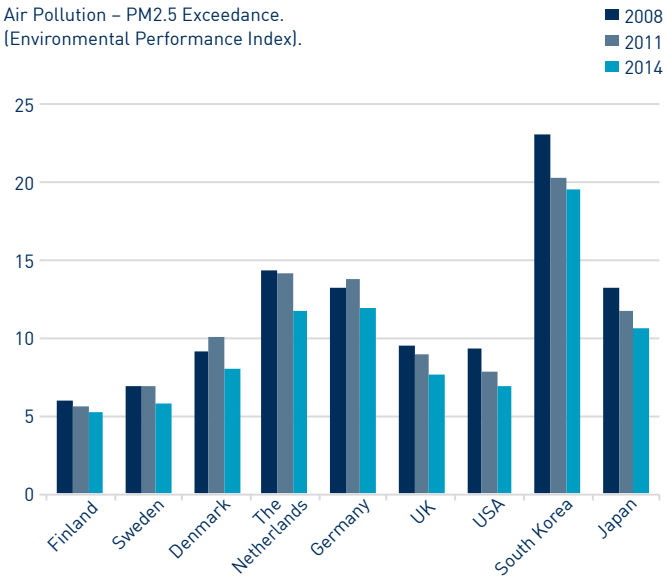
INDICATOR 4.27.

Risk of water and air pollution to human health. (Environmental Performance Index).



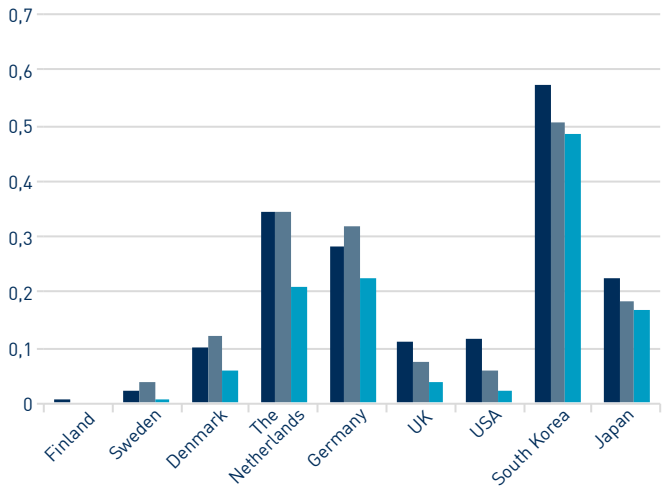
INDICATOR 4.28.

Air Pollution – PM2.5 Exceedance. (Environmental Performance Index).



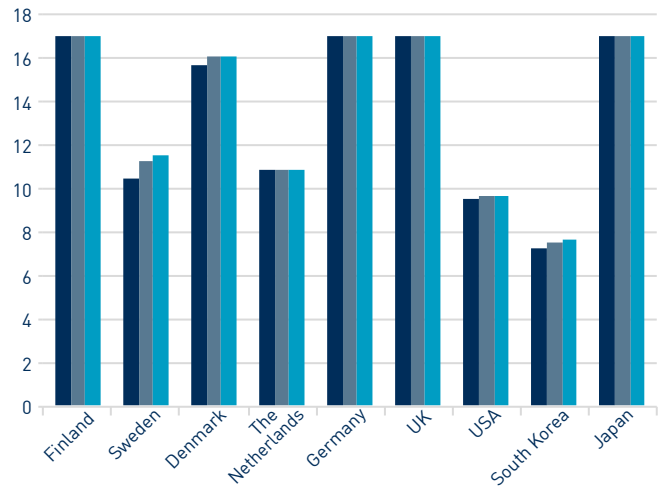
INDICATOR 4.29.

Population weighted exposure to PM2.5 (three- year average). (Environmental Performance Index).



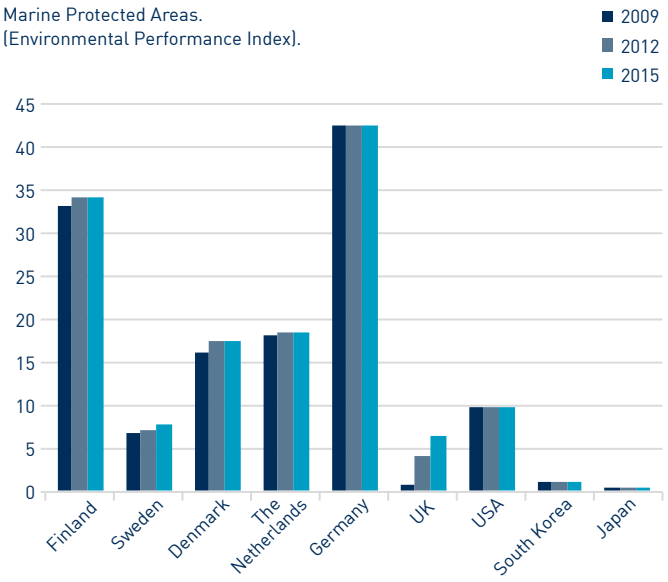
INDICATOR 4.30.

Terrestrial Protected Areas (National Biome Weights). (Environmental Performance Index).



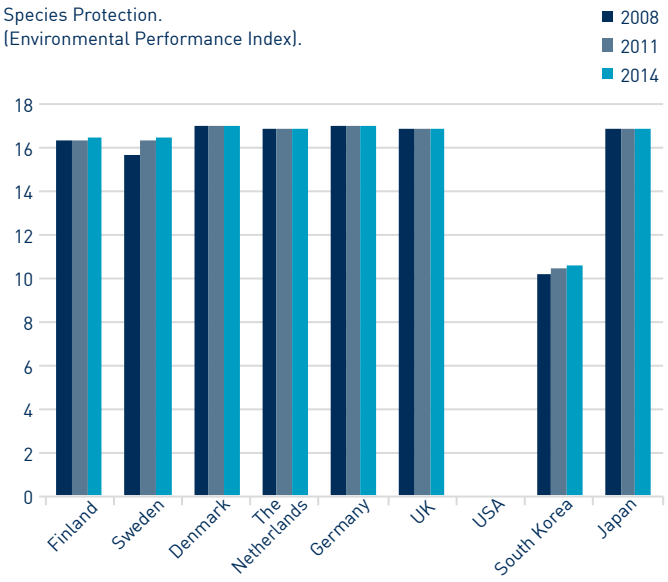
INDICATOR 4.31.

Marine Protected Areas. (Environmental Performance Index).



INDICATOR 4.32.

Species Protection. (Environmental Performance Index).



Indicator 4.29. Percentage of the population whose exposure to microscopic particles exceeds the risk level set by the World Health Organisation.
Air Pollution - PM2.5 Exceedance. Proportion of the population whose exposure is above WHO thresholds (10, 15, 25, 35 micrograms/m3). Environmental Performance Index (Yale Center for Environmental Law & Policy).

Indicator 4.30. Protected terrestrial areas, per cent.
Terrestrial Protected Areas (National Biome Weights). Percentage of terrestrial biome area that is protected, weighted by domestic biome area. Environmental Performance Index (Yale Center for Environmental Law & Policy).

Indicator 4.31. Protected marine areas, per cent.
Marine Protected Areas. Marine protected areas as a percentage of EEZ. Environmental Performance Index (Yale Center for Environmental Law & Policy).

Indicator 4.32. Protection of the habitats of different animal species, percentage.
Species Protection. The average area of species - bird, mammals, and amphibians - distributions in a country under protection. Environmental Performance Index (Yale Center for Environmental Law & Policy).

Combined indicators

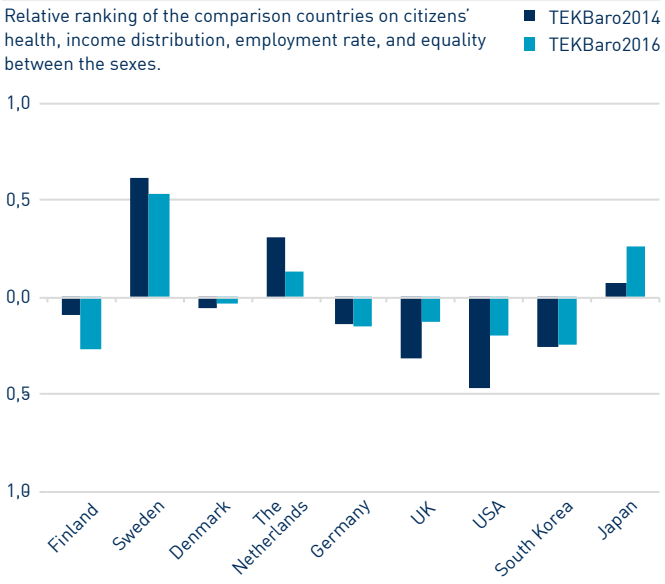
Indicator 4.33. Relative ranking of the comparison countries on population health, income distribution, employment rate, and equality between the sexes. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

Indicator 4.34. Relative ranking of the comparison countries on environmental protection measured by the proportion of total energy production accounted for by environmental protection expenditure, greenhouse gas emissions, energy intensity, and renewable energy sources. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

Indicator 4.35. Relative ranking of the comparison countries on the state of the environment measured by the proportion of GDP accounted for by sulphur oxides, oxides of nitrogen, and volatile organic compound emissions, by impurities in the water and air, by protected land and marine areas, and by the habitats of animal species. Combined indicator, in which average of the countries = 0. If the score is positive, the country's achievements are better than average. Correspondingly, if the score is negative, the country's achievements are below average.

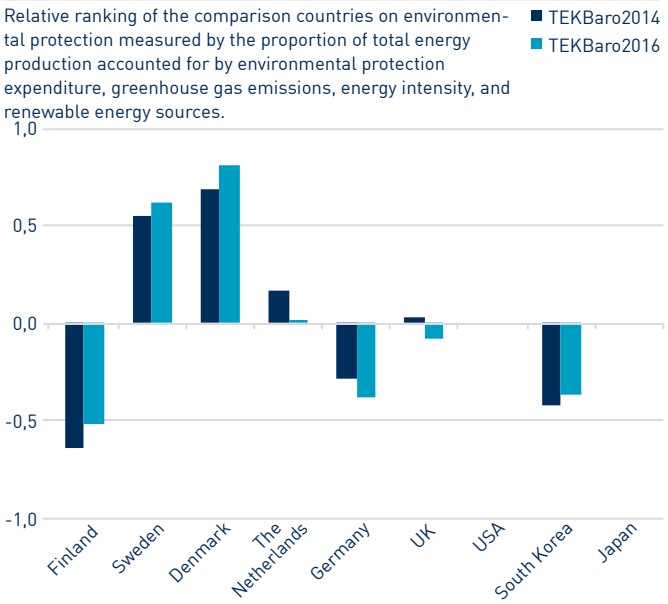
INDICATOR 4.33.

Relative ranking of the comparison countries on citizens' health, income distribution, employment rate, and equality between the sexes.



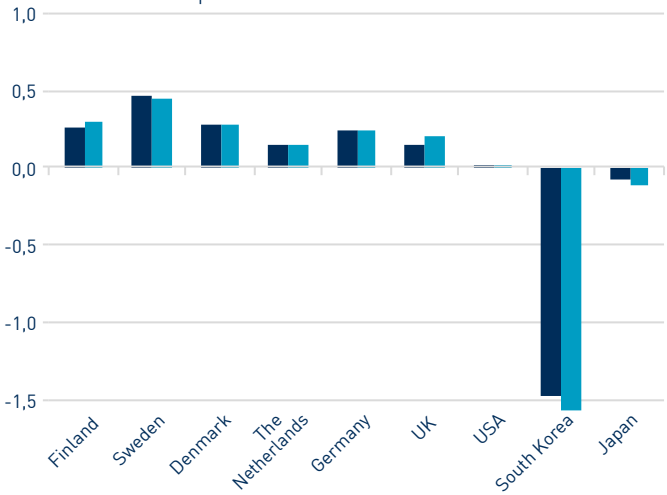
INDICATOR 4.34.

Relative ranking of the comparison countries on environmental protection measured by the proportion of total energy production accounted for by environmental protection expenditure, greenhouse gas emissions, energy intensity, and renewable energy sources.



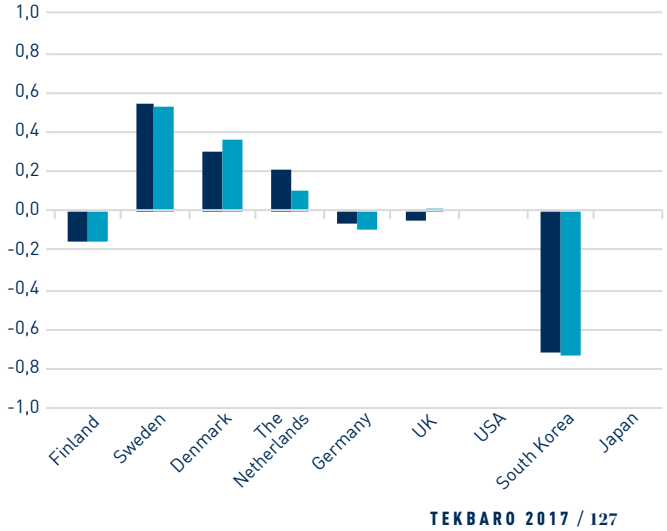
INDICATOR 4.35.

Relative ranking of the comparison countries on the state of the environment measured by the proportion of GDP accounted for by sulfur oxides, oxides of nitrogen, and volatile organic compound emissions, by impurities in the water and air, by protected land and marine areas, and by the habitats of animal species.

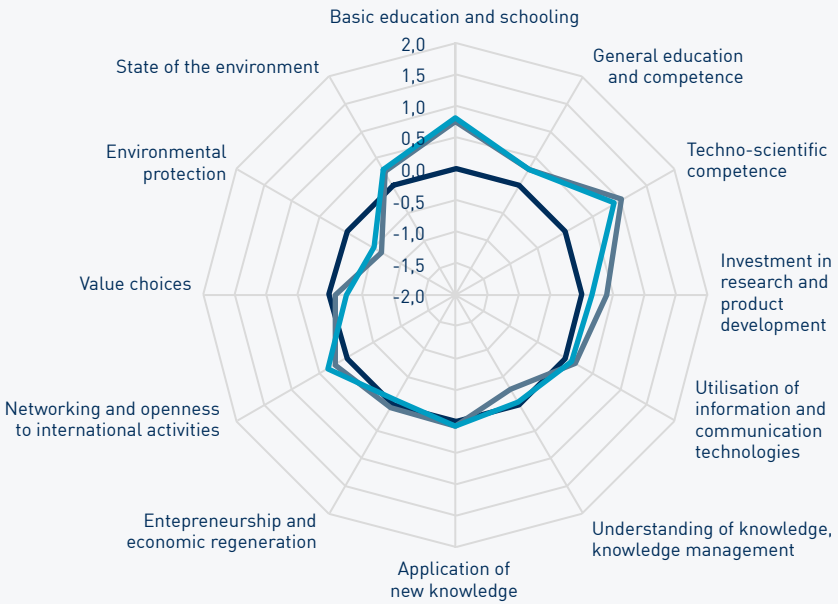


INDICATOR 4.36.

Relative ranking of the comparison countries on citizens' health, income distribution, employment, equality between the sexes, environmental protection and the state of the environment, overall indicator.

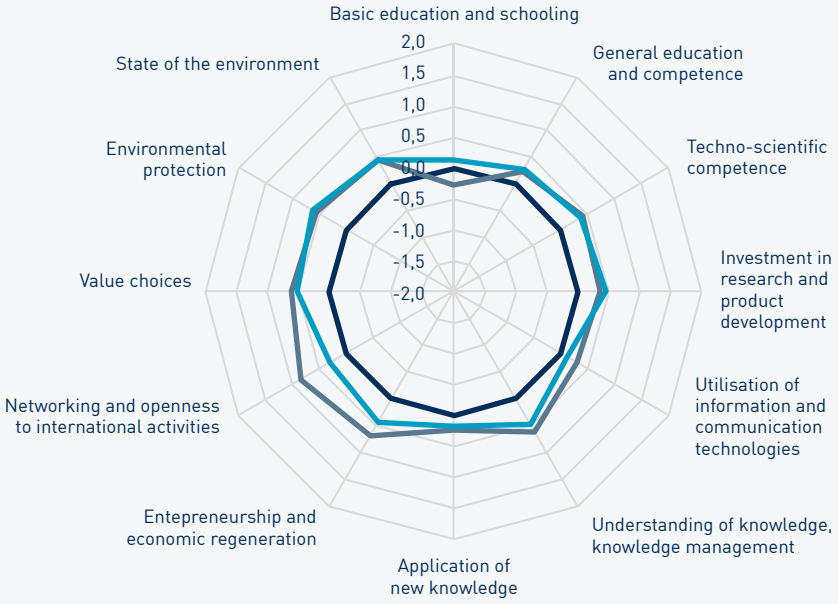


APPENDIX 3. COUNTRY GRAPHS



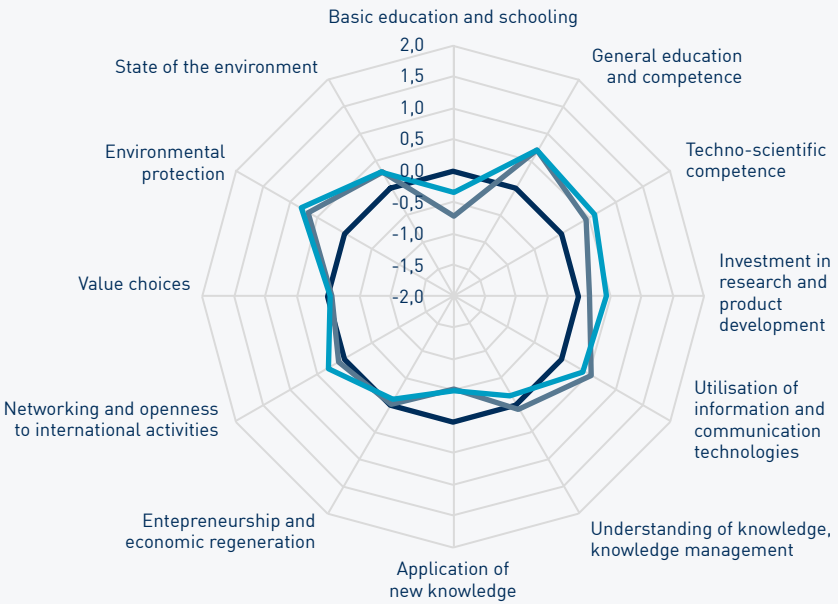
COUNTRY GRAPH 1.

Finland's strengths and weaknesses in comparison to the reference group countries.



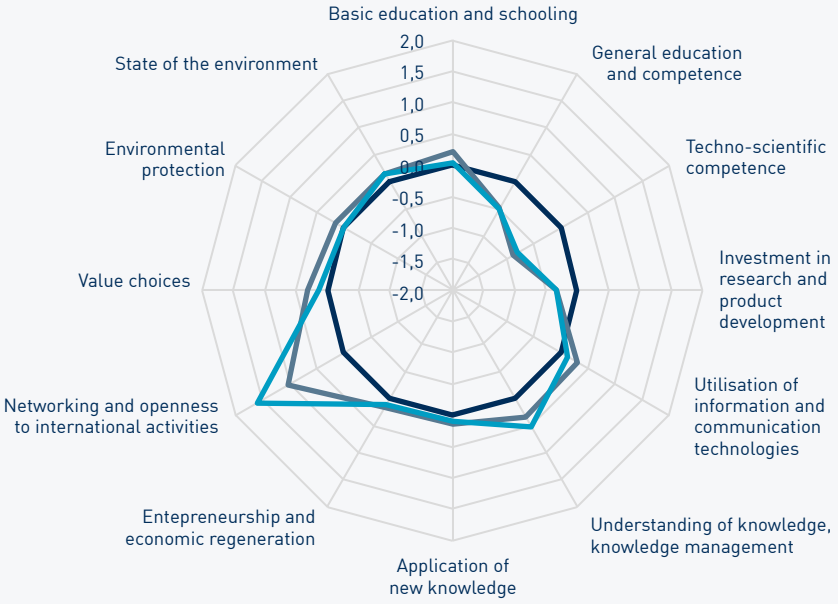
COUNTRY GRAPH 2.

Sweden's strengths and weaknesses in comparison to the reference group countries.



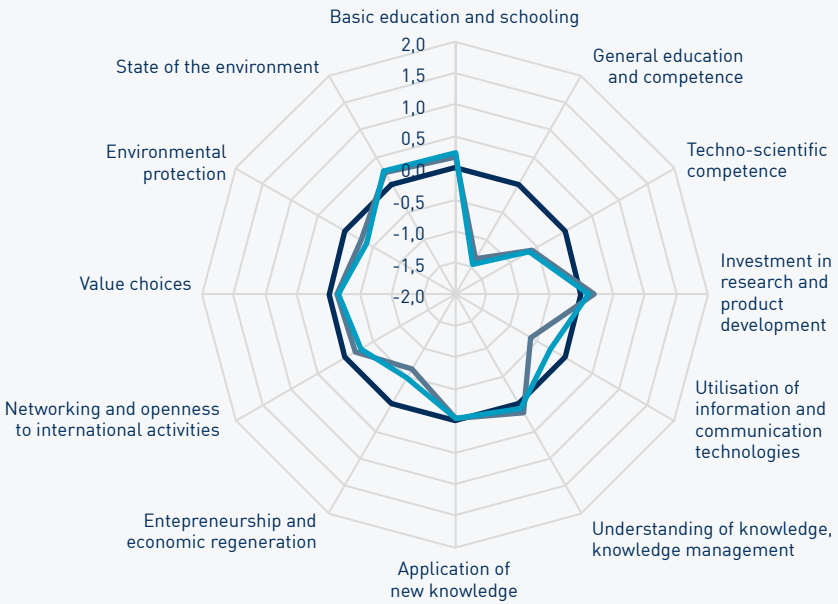
COUNTRY GRAPH 3.

Denmark's strengths and weaknesses in comparison to the reference group countries.



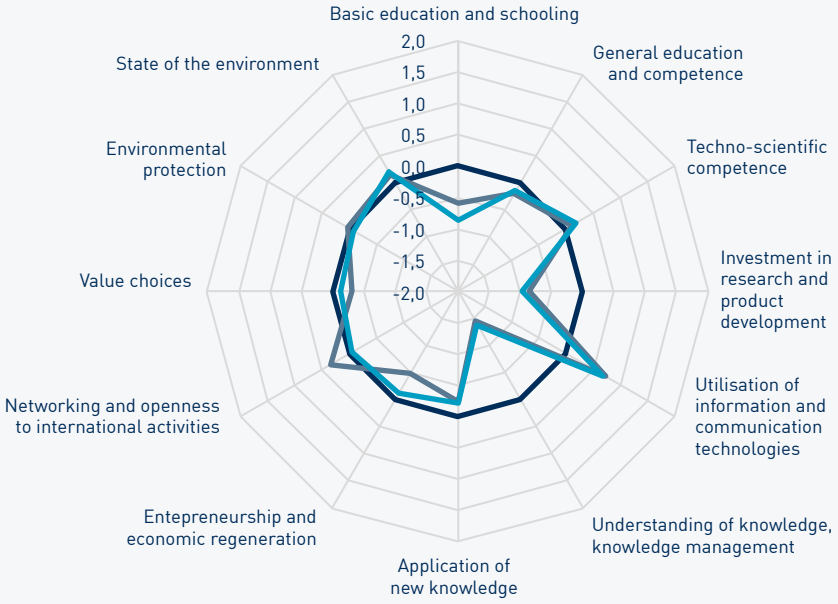
COUNTRY GRAPH 4.

The Netherland's strengths and weaknesses in comparison to the reference group countries.



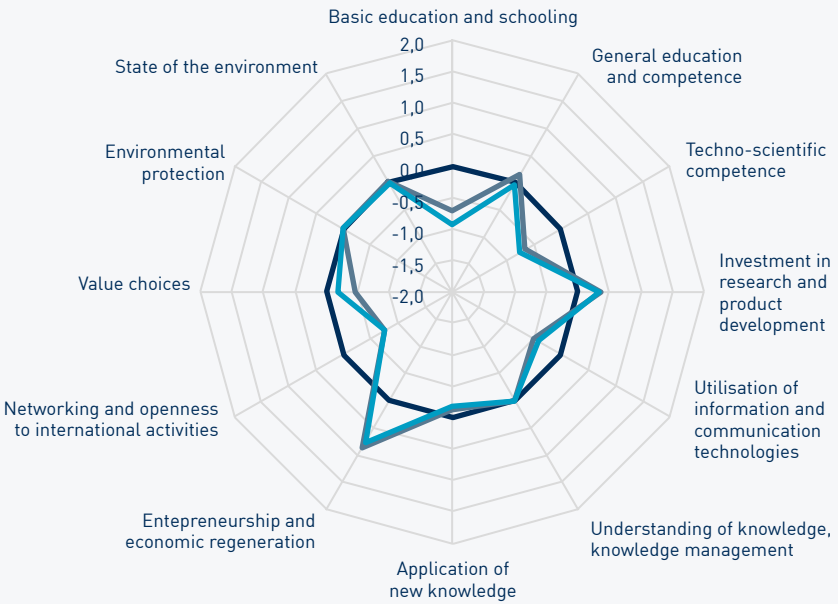
COUNTRY GRAPH 5.

Germany's strengths and weaknesses in comparison to the reference group countries.



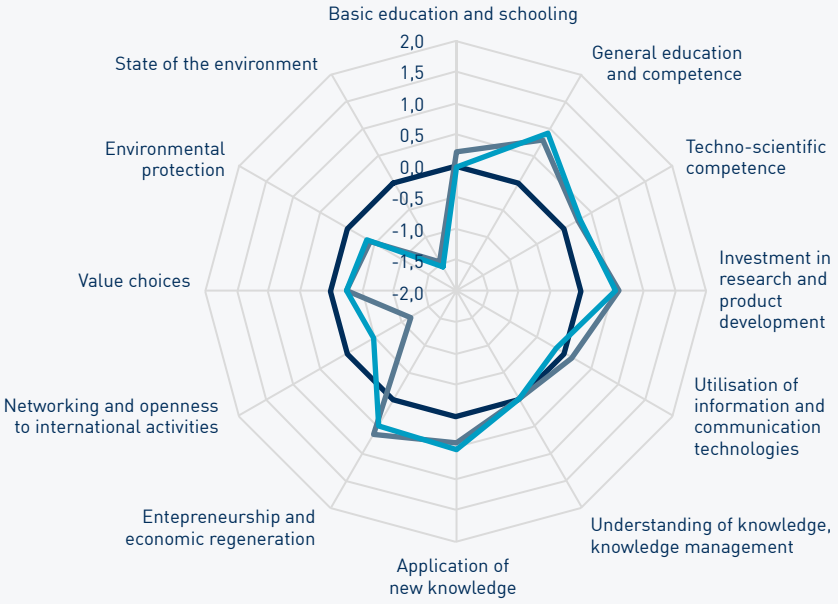
COUNTRY GRAPH 6.

UK's strengths and weaknesses in comparison to the reference group countries.



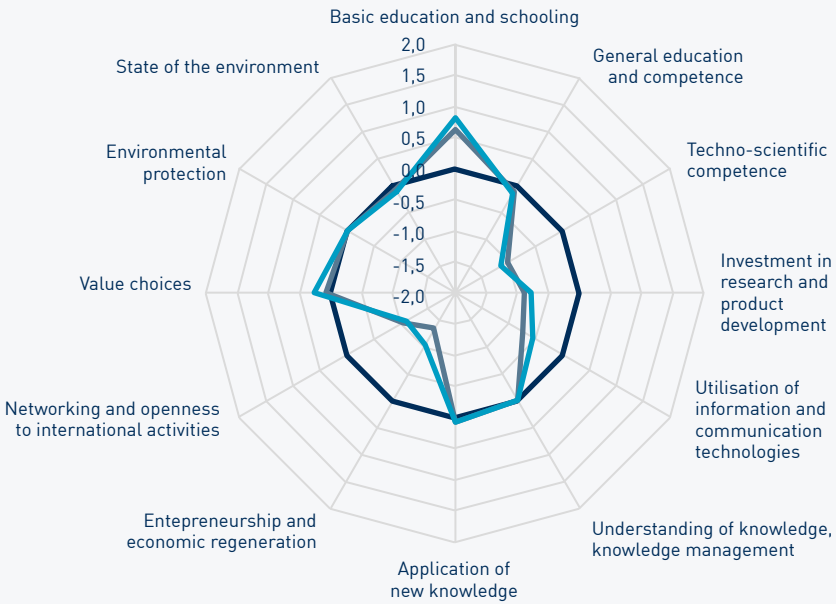
COUNTRY GRAPH 7.

USA's strengths and weaknesses in comparison to the reference group countries.



COUNTRY GRAPH 8.

South Korea's strengths and weaknesses in comparison to the reference group countries.



COUNTRY GRAPH 9.

Japan's strengths and weaknesses in comparison to the reference group countries.

TEKBARO 2017

Technology Barometer developed to measure citizens' attitudes and the nation's orientation towards a knowledge-based society

Academic Engineers and Architects in Finland TEK and the Technical Research Centre of Finland VTT have developed the Technology Barometer to measure the state of our country's technical-scientific competence and development. The tool provides a more in-depth view of the state of societal development in different countries than is customary.

In recent years our working environment has become both challenging and surprising. The economic downturn has gone on for longer than expected. In these conditions, how have the innovation systems of Finland and of the other eight countries responded to the challenges of the time? In what direction is the situation expected to develop? In this latest Barometer, as in the previous one, the traditional number of eight comparison countries has with the addition of South Korea been increased to nine.

TECHNOLOGY BAROMETER 2017

TEKNIIKAN AKATEEMISET

과학기술정책연구원 STEPI
SCIENCE AND TECHNOLOGY POLICY INSTITUTE

VTT